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SMEAJ-'81

23rd. ISSUE

EDITED BY :—

Sri Sabyasachi Sarkar

Sri Manas Kumar Samanta

Sri Sukanta Dey Roy

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PRINCIPAL

BENGAL ENGINEERING COLLEGE
P. O. BOTANIC GARDEN, HOWRAH - 711 103

12th March, 1981

MESSAGE

I am glad to learn that the Students' Society of Mechanical Engineers of this College is bringing out its annual publication—The Society of Mechanical Engineers' Journal—sometime this month.

The Society must be congratulated for having ventured to publish this annual technical magazine by overcoming all the barriers due to soaring prices of printing and stationery and difficulty in procuring advertisements.

The SME Journal is one of the oldest of Students' Society Journal of the college. It has built up a good tradition and set an example for the other Society Journals to emulate. I do belive that the present students of the Mechanical Engineering Department will come forward to give of their best not only to zealously maintain but also enrich the enviable standard of their Society Journal.

I convey my greetings and good wishes to the Society and our Mechanical Engineering under-graduates on this occation and wish them all the best in the years ahead.

Sd/-
A. K. Seal.
Principal,
Bengal Engineering College.

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DR. D. N. ROY
PROFESSOR & HEAD,
DEPT. OF MECHANICAL ENGINEERING
BENGAL ENGINEERING COLLEGE

FOREWARD

This is a great pleasure that the Society of Mechanical Engineers, B. E. College, is going to publish its annual S. M. E. Journal. After a lapes of two years the annual journal of the Society is going to be published this year with the efforts and initiative of the present members of the Society, which are really praiseworthy. The students have dong it as a part of their extra-curricular activities in the department. In these hard days it is a quite defficult job to bring out a journal like this. But our energetic and sincere students have done it successfully.

I hope this issue will maintain the good name and tradi ion of the department. I also hope that the continuity of bringing out of annual journal of this Society will be maintained by our future students.

I am happy to write a foreward for this journal and wish the Society all its success.

Sd/-
D. N. Roy
Professor & Head of the Department
of Mechanical Engineering
B. E. College : Howrah.

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&
THE MACHINES

VOICE FROM OUR GENERAL SECRETARY

Our annual publication, "SMEAJ-81", is in your hand. After a silence of few years, we are again going to circulate our ideas, feelings and achivements, in the sphere of technology and science in the matrix of Mechanical Engineering, to our beloved and well-wisher readers. We toiled our level best in the past; survived in the present; and long for keeping our existance in the future. The Society of Mechanical Engineers, Bengal Engineering College, welcomes and supplicate for new ideas, co-operation and help to all of you, for our future success.

It is a pleasure for me to sit on the chair of the General Secretary of this age-old society. This society works for the unity, co-operation and communication among the staffs and the students of this department. Apart from these, this Society of Mechenical Engineers acts as the canal for the intelectual flow of our members who in the near future will be the responsible and honoured persons of any technical industry. This society is the platform, on which we, the students and the staffs do our best for the betterment of Mechanical Engineering, with hand in hand and rubbing shoulder with shoulders.

Haunted by the routine-oriented life, squeezed by the academic pressure and disgraced by adverse circumstances, we still managed some time to run the society and perform its activities. Though not Himalayan, yet our achivements are not to be neglected.

Seminars are the intelectual foods for any budding engineer. We conducted several seminars for our members on various topics. Though it will make a long list, the semenar on "Industrial Management" by Mr. Dipti Sen, General Manager, Andrew Yule, the seminar on "Machine Design" by Mr. Achyut Ghosh, Director, Metco Group, the seminar on 'Steam Power Plant' by Mr. T. Bharadwaj, Manager, Power-cell, D.C.P.L. are worth mentioning.

Visit to industries enable us to clear up the ideas of difference between the theories and their practical applications. Last year, in 1980 we conducted an industrial tour-cum-excursion to Ranchi. Prof. T. K Roy escorted about forty students to HEC and MECON, Ranchi. We also conducted a tour to the places of interests in Ranchi at the same time. We organised industrial tours to Hindusthan Motors, J. K. Steels, Indo Japan etc. and enjoyed a picnic on the Christmas eve at Phuleswar. If the Government extends some financial help, we can organise tours to the famous industries at a distant places.

To be a 'Model Engineer', construction of experimental models are must. Our model section encourages and assists the students in modelling their constructive ideas in the field of Engineering.

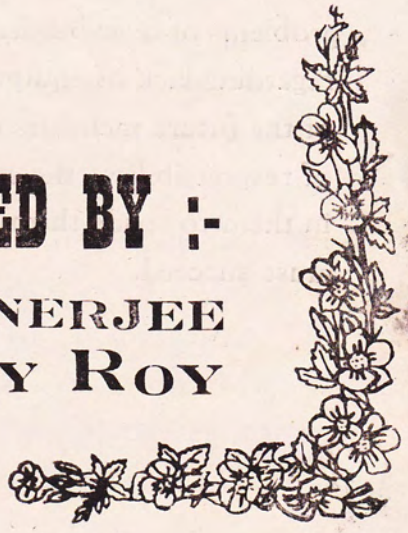
Academic potential blended with honest and progressive culture, results in confident and pure engineers. We welcomed our freshers to our department through a cultural function which was a grand success. Our members took a active part in most of the cultural functions of our college and hoisted the glory of the society.

We know what we have done is very little, compared with what had to be done. We could have been done a little regarding shortage of staff and problems of over-burden on present staffs. A little could have been done regarding lack of equipments in laboratories and workshops. It is the duty of the future members of our society to compensate and to carry the torch of responsibility, the emblem of glory and essence of unity of the society in them to stride through the catalogue of duties in front of us. And we must succeed.

Manas Kumar Samanta
General Secretary
Society of Mechanical Engineers
BENGAL ENGINEERING COLLEGE

COVER DESIGNED BY :-

SRI SANDIP BANERJEE
SRI SUKANTA DEY ROY



EDITORIAL.

We were travelling all along. The waves were high & strong, the wind was fierce, every thing was hostile. But we never gave it up. We kept our vessel moving all the time and reached the shore after long five years, —started in seventy-six and finished in eighty-one. We are proud of our determination, our labour and above all our unity.

It seemed that we were living in the beautiful fairy land for the last five yeras and we all forgot our duties and activities, rather we were having an illusive sleep. But thanks to our once forgotton responsibility; our love for our department that our sleep didn't last long. We started and one fine morning of December, Nineteen hundred and eighty, we, hand in hand came forward with a desire of seeing the 23rd Issue of the SMEAJ. That was the bud of a great achievement, which we are now enjoying with the whole of our soul.

Academic pressure, high cost of papers and other necessary things, difficulties in collecting advertisements, all stood our way like demons. But our unity, our determination were always with us in this great march towards a great success.

At this very moment of happiness and triumph I, on behalf of myself and our society convey best wishes to all the professors, staff and students of our departmet and thank all the advertisers for helping us in this great achievement.

SABYASACHI SARKAR
5th Year, M. E.

CONTENTS

SMEAJ

SOLID LUBRICANTS.

Prof. N. R. Chakrabarti
M. E. DEPARTMENT
B. E. COLLEGE, HOWRAH-711103.

Iutroduction :

A solid lubricant is usually defined as a material that provides lubricationbetween two surfaces in relative motion under essentially dry conditions. The most common of the present-day solid lubricants are graphite, molybdenum disulphide, polytetrafluoroethylene (PTFE), polychlorotrifluoroethylene (PCFE), talc, mica, various sulphides of titanium and tungsten, tellurides, and selenides. The use of graphite as a bonded solid lubricant is relatively recent[1]. The use of MoS_2 as a lubricating solid started in the early 1940s, and it is now the most widely used solid lubricant. Talc and mica are typical fillers for some heavy duty greases such as car axle grease; these also find applications as lapping compounds for smoothing out frictional and decorative surfaces.

Solid lubricants may be in the form of powder dispersed in grease or fluids, surface films as oxides, or bonded by phenolics, epoxy, polyimide resins, fused ceramics, etc. or as retainers, such as the cages of ball bearings. Bonded solid lubricants are generally applied by spraying, brushing, or dipping. Other advanced methods include plasma spraying and electrophoretic deposition. Surfaces to which the binder in the solid film must adhere are usually treated prior to deposition so as to enhance the wear life. There are, in general, three different ways in which the solid lubricants (possessing lamellar structures) can be applied as solid-film lubricants to metal surfaces.[2],[3]

(i) Incorporation of lamellar solid into a suitable resin or binder, and gluing to the surface,

(ii) Depositing solid as fine powder and rubbing it into the surface; and

(iii) Formation of materials by chemical reaction at the surface itself.

Advantages and Disadvantages :

Solid lubricants possess the advantage of good stability at extreme temperatures and in Chemically reactive environments. These are generally of lighter weight, they require fewer seals and the necessity for a recirculating oil system (with pump and other components) is eliminated. They can be used on components that are difficult to lubricate with conventional liquids.

The disadvantages include (i) higher frictional coefficients than those of hydrodynamic lubrication, (ii) finite wear lives of dry film coatings, (iii) some inevitable wear owing to solid sliding contact, (iv) low or no cooling capacity.

Classification :

The solid lubricants may be classified depending upon their origin as being : (i) Organic (e.g., graphite and MoS_2);

(ii) Inorganic (e.g., PTFE and PCFE);

(iii) Metallic (e.g. Pb, indium, Au, Ag and Ba); and

(iv) Combination (e.g., MoS_2 – graphite – sodium silicate, MoS_2 – graphite – Mo, etc.)

Mathematical Properties for Analysis :

The most important mathematical property of the solid lubricants, from the lubrication point of view, is the non-Newtonian viscosity characteristics possessed by these. The shear viscosity is a function not only of temperature but also of the shear stress and rate of shear.

The general methods of the absolute rate theory lead to the following expression for the viscosity :—

$$\eta = [\, hN/V \exp(-\Delta S^*/R)\,] \exp(\Delta H^*/RT) \quad \ldots \quad (1)$$

where

h = Plank's constant;

N = Avogadro number;

V = molar volume;

ΔS^* = the entropy of the process of viscous flow;

R = the gas constant;

ΔH^* = the heat of activation of the viscous flow process;

T = the absolute temperature.

As the molar volume varies slightly with temperature, and the quantity ΔS^* is usually assumed to be independent of temperature, eqn. (1) may be rewritten as :—

$$\eta = B \exp(E/RT) \quad \ldots \quad (2)$$

where

E = the activation energy of the flow process; and

B = a constant.

Eqn. (2) is called the Arrhenius–Frenkel–Eyring formula.

The dependence of the apparant viscosity on the rate of deformation has been treated by H. Eyring within the framework of the general theory of absolute reaction rates. According to the conceptions of this theory, the elementary flow process in a quasicrystalline body, consists in crossing the energy barrier by a molecular–Kinetic unit prossessing sufficient energy to do it. These jumps occur constantly in all directions with equal probability, so that no definite direction of flow is present. In the absence of the external force field, the jumping frequency depends on the height of the potential energy barrier and the size of the molecular–Kinetic units and is determined by the specific structure of the lubricant and the temperature. Eyring's theory yields the jumping frequency as

$$\nu_0 \propto \exp(-E/KT) \quad \ldots \quad (3)$$

where

E = the activation energy of flow, determined by the height of the potential barrier; and

K = Boltzman's constant.

The scheme of jumps over the potential barrier in a model system, which is a set of spherical particles. is shown in the figure below.

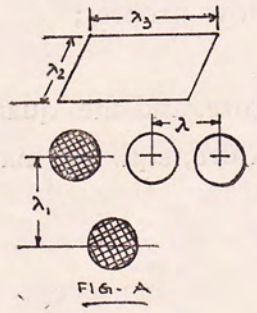


FIG- A

Fig —A Showing the jump of a molecular-Kinetic unit over the P. E. barrier.

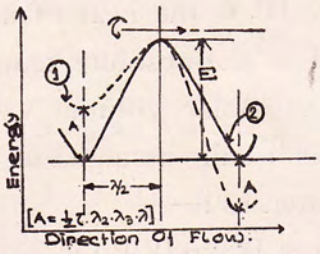


Fig.— B

(1) Indicates the curve with external force applied.
(2) Indicates the curve in the absence of external force.

Fig.—B. Showing deformation of the potential barrier under the influence of shear.

With each jump a molecular-Kinetic unit moves a distance "λ" so that the total displacement per unit time is given by

$$\Delta u = \lambda \nu_o [\exp(A/KT) - \exp(-A/KT)] = 2\lambda\nu_o \sinh(\tau\lambda_2\lambda_3/2KT) \quad \ldots\ (4)$$

where

ν_o = number of jumps per unit time in the lubricant when there is no external force acting;

$A = 0{\cdot}5.\tau.(\lambda_2\lambda_3)$ = work done upon movement to the top of the symmetrical potential barrier at a distance of $\lambda/2$.

The quantity Δu, given by eqn. (4), is basically the difference between the velocities of two adjacent layers, since under the action of stresses "τ", a relative displacement of the adjacant layers of the solid lubricant (in emulsion form) occurs. The apparant viscosity, if defined as

$\eta = \tau/(\Delta u/\lambda_1)$,

may now be expressed as

$$\eta = \tau\lambda_1/[\ 2\lambda\nu_o \sinh (\tau\lambda\lambda_2\lambda_3/2KT)\ ] \quad \ldots \quad (5)$$

As a first approximation, we may assume

$\lambda_1 = \lambda/2$; $\omega = \lambda_1\lambda_2\lambda_3$,

so that eqn. (5) now takes the form

$$\eta = \eta_o\ [\ Z/\sinh Z\ ] \quad \ldots \quad (6)$$

where

$Z = \tau\omega/KT$; and $\eta_o = KT/(4\ _o\omega)$.

The value of "Z" at which noticeable departure from Newtonian flow conditions occur can be obtained from eqn. (6). Eqn. (6) describes the single-parameter dependence of (η/η_o) on "Z" or "τ". Also, substantial structural changes may occur, even at low shear stresses, for thixotropic substances. So attempts have been made to generalise[4] the Eyring formula in the form :—

$$\eta = \sum_{i=1}^{N} (x_i\theta_i/B_i).\ \frac{\sinh^{-1} (\gamma\cdot\theta_i)}{(\gamma\cdot\theta_i)} \quad \ldots \quad (7)$$

where

x_i = Characteristic sizes of different molecular – Kinetic units;

θ_i = Characteristic relaxation times;

B_i = Empirical constants; and

$\gamma\cdot$ = Shear rate.

For details, the reader is to consult reference no; (5).

Some Applications :

Bonded coating of MoS_2 are used in aerospace applications and on metal-cuttings tools, cams, control rod mechanisms of nuclear reactors, sleeve bearings, small gears, universal joints, self-adjusting brake screws, and lubricated valves. MoS_2 and graphite are often used in conveyor bearings in an oven. Thin, lead-coated balls and raceways of ball bearings, lightly

loaded, have proved reliable under space vacuum for up to 15,000 hrs. of operation. PTFE is sometimes used to impreguate porous metals to reduce friction; it is used with other materials (like fibreglass, mica, etc.) as either a matrix or mixture to successfully meet the abnormal requirements of high temperature and high vacuum. Glass powder mixed with binders like bentonite, finds use as a lubricant during the extrusion process.

References :

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IN SEARCH OF NEW HORIZON OF POWER

By : PRADIP BASU
CHANCHAL KUMAR NATH
TUSHAR KANTI NANDA

Power and Energy are two very imporrant factors whose utility and importance need no explanation. These are the main pillers on which human civilisation stands. Industry as well as in agriculture, energy in the most important infra-structure, the absence of which will simply cause a total deadlock. Whether we will move further with tremendous pace with the help of enough energy or we will retreat to our old primite days is the burning question all over the world. The world of science and tochnology is still hankering after a new source of energy to foster a rapid total growth of manking This hunter for energy and power leads us in the quest of several sources. These sources of energy are :— (1) Thermal power (2) Atomic power (3) Hydro-electric power (4) Tidal power (5) Geo-thermal source of energy (6) Wind power (7) Bio-gas and Bio-mass source of power and lastly (8) Solan energy.

Dear reader, before entering into this serious problem in depth, let us have a look over the present power situation in India. The performance in the field of electricity generation in the last two decades is given below :

Year	Installed capacity Million k.w.	Generation Million k.w.h.	Power generated per k.w. of installed capacity k.w.h.
1960-1981	4.7	16,937	3604
1965-1966	9.0	32,990	3666
1970-1971	14.7	55.828	3798
1975-1976	20.1	74.230	3942
1978-1979	26.5	103328	3899

Not only electricity, petroleum is also a major source of power. It is needless to mention that India is suffering from an acute shortage of petroleum. In 1979, the country had imported 15 million tonnes of crude oil and 5 million tonnes of petroleum products costing about Rs. 3800 crores in spite of her own oil production of 14 million tonnes 63% of India's foreign exchange is paid to meet her oil imports. Besides, like other developing countries in the world India has a regular problem of paying increased prices for buyign petroleum from OPEC countries.

The per capita energy consumption of electricity in different zones of India can be estimated from the graph given in the next page.

From the graph we find that the per capita energy consumption will increase from 225 k.w.h. in 80–81 to 370 k.w.h. in 88–89. including an increase of 64.4% over the present consumption. According to Prasad Committee the power requirement at the end of next two decades will rise to 108,000 M.W. This would mean installing on an average about 4000 M.W. annually which is really a herculian task.

Of late, our Government has become aware of this grave situation, which is developing rapidly. Some of the steps taken by the Government of India to face this situatlon are :–

(1) 20,000 M.W. capacity to be commissioned during 6th plan and 28,000 M.W. during 7th plan.

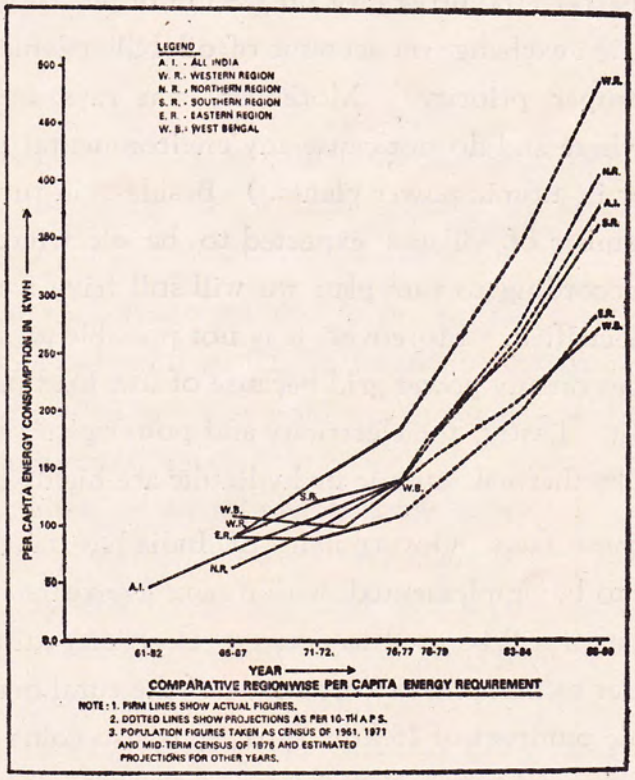
(2) Installed capacity to be raised to 2.7 times over the present capacity by 1990-91.

(3) To pay more attention to Rural electrification and supplying power to agricultural sector.

(4) Evaluation of National transmission grid.

(5) Crash programme of training and development personnel connected with power sector.

Although more stress is given on rural electrification and pump-set energising, still the achievement so far made is far away from the goal. From a recent report the number of villages so far electrofied in 1980 is 21700 and number of pumps energised in agricultural field is 285000. Although these figures are higher than the previous year's (18,405 and 3,51,791 respectively) still is far away from the total number of villages of 5,76000 in India. So we see that in order to have a simultaneous growth both in agriculture and industry we should divert our attention to another new source which is 'Solar energy'. At present two systems are used in converting solar radiation into useful energy. They are:- (i) Solar thermal (ii) Solar electric.



In solar thermal system the radiation is used to warm the fluid and this stored energy can be used for various purposes. Solar electric system converts the radient solar energy directly into electricity through photovoltaic cells. The photovoltaic cells have pure and polished silicon wafers. The semi-conductors embeded into wafers are activated by sun light which in turn generate electricity.

India is truly a land of abundant sun shine. The average solar radiation to which India is exposed to is estimated at 600 calories per sq. cm per day. Moreover, our motherland is graced by yealy 3000 hrs. (approximately) of sunshine which can bring brighter days in our remote villages which still live in bullock cart age and plunges into darkness after sunset. The equivalent energy of solar radiation on every acre of land in India is 10 barrels (1 barrel 1160 litres) of oil. So in order to reduce the huge drainage of foreign exchange on account of oil bill payment, solar energy should have proper priority. Moreover, sun rays are inexhaustiable, available everywhere and do not cause any environmental pollution (which is a main factor in atomic power plants.) Besides, in rural electrification scheme total number of villages expected to be electrified within 1990 is 4,51,000. So according to our plan we will still have a total of 1,25,000 villages to be electrified. Moreover, it is not possible to supply electricity to remote villages on any power grid because of low load potential and high transmission lost. Lastly, the electricity and power generation by conventional methods like thermal, atomic or hydraulic are highly capital in tensive.

Aware of these facts, Government of India has taken up a Rs. 120/- million project to be implemented within next five years. In this projects photovoltaic system will be used to convert electricity directly from solar radiation in order to meet the energy needs of the rural masses. Field trial of a photovoltaic pumpset of 25 k.w. capacity is also going on and expected to complete by the end of this year.

India's first solar power based lighting system was installed recently at Choglamsar a remote village in Ladakh. The system is providing electricity to light 17 fluorescent lamp in a 20 bed hospital. There are also several important uses of solar thermal system. The heat obtained from a collector is used to construct paddy and vegetable dryer, solar cooker, solar cooling systems, etc. Even timber drying is done with the help of solar radiation. A flate plate collector is also used to heat 80,000 litres of water from 10°C to 25°C for an all weather swimming pool of the ITDC in Delhi's Quatab Hotel.

Many foreign countries have launched different big programmes of hernessing solar power for various uses. Russia has developed a carpet that can capture solar energy and supply electricity for a house throughout the whole day. Soar pond of Isreal has been a big sensation. Suluchuli, the first solar powered village located in Arizona, U.S.A. will meet all its energy needs from the sun.

IIT (Madras) and BHEL in collaboration with a West German firm have developed a sun based 10 k.w. solar electric generator for the use in rural areas. It may help to decentratise the cottage industries in rural areas.

Apart from all the advantages and uses, so far mentioned this new source has certain shortcomings. Those dis-advantages are :—

(1) It is mainly used in house hold and in small scale industry. It can be used in large industries.

(2) It is very much sensitive to weather variations.

(3) The cost of power generation so far made is very high. In the 10kw generator devised by IIT (Madras) and BHEL cost per unit of power is Rs. 5/-. The cost of the solar pumps is too exerbitant to make their use practical. But this new source is in very preliminary of exploration stage. Better product design and mass production may bring down the higher cost of production of these units.

In order to keep the wheels of progress moving with a faster rate we should stress on this particular source of energy. It should be remembered that simultaneous progress in industry and agriculture can make a country totally developed. Dr. Guraraja, the Director, Department of Science and Technology predicts "Solar energy can and will play a vital role in the future energy scence of our country. Particularly in rural areas. It will be the leading candiate (not solar) energy sources in future. Lastly, let us remember those great words of Yudishthira in Mahabhartam : –

You O sun, are the eye of the world,
You are the soul of all embodied beings
You are the source of all creatures
You are the discipline of all engage in work.

NOISE AND VIBRATION CONTROL OF ROLLER-CHAIN & SPROCKET DRIVES

Sandip Banerjee, (5th Year)
Mechanical Engineering

Vibration is one of the primary causes of mechanical failures of machines and mechanisms. When mechanical vibrations are transmitted to air, noise levels may be high enough to endanger human hearing. At present a world wide effort is being made to control and calm down vibration effectively, quickly and economically.

Roller chain and sprocket drives have intrinsic characteristics that make it impossible to eliminate mechanical vibration and noise completely. Mechanical impact occurs every time a sprocket tooth engages a roller, causing vibration. Power transmission is non-uniform, which also causes vibration. The length of the chain between the sprocket wheels tends to vibrate continuously.

Two Japanese researchers have studied the noise of roller chain drives using a test set-up (as shown in Fig.A) designed to isolate various sources of noise.

It has been identified that roller chain drives have three main components of noise. The first, meshing noise, is caused by mechanical impact when a sprocket tooth engages a roller. The second, transmission noise, is caused by the angular fluctuation of power transmission (the period of this fluctuation is equal to the travel time of one pitch of the chain). And the third, "Knock" is caused by impact of the roller chain against the chain guide.

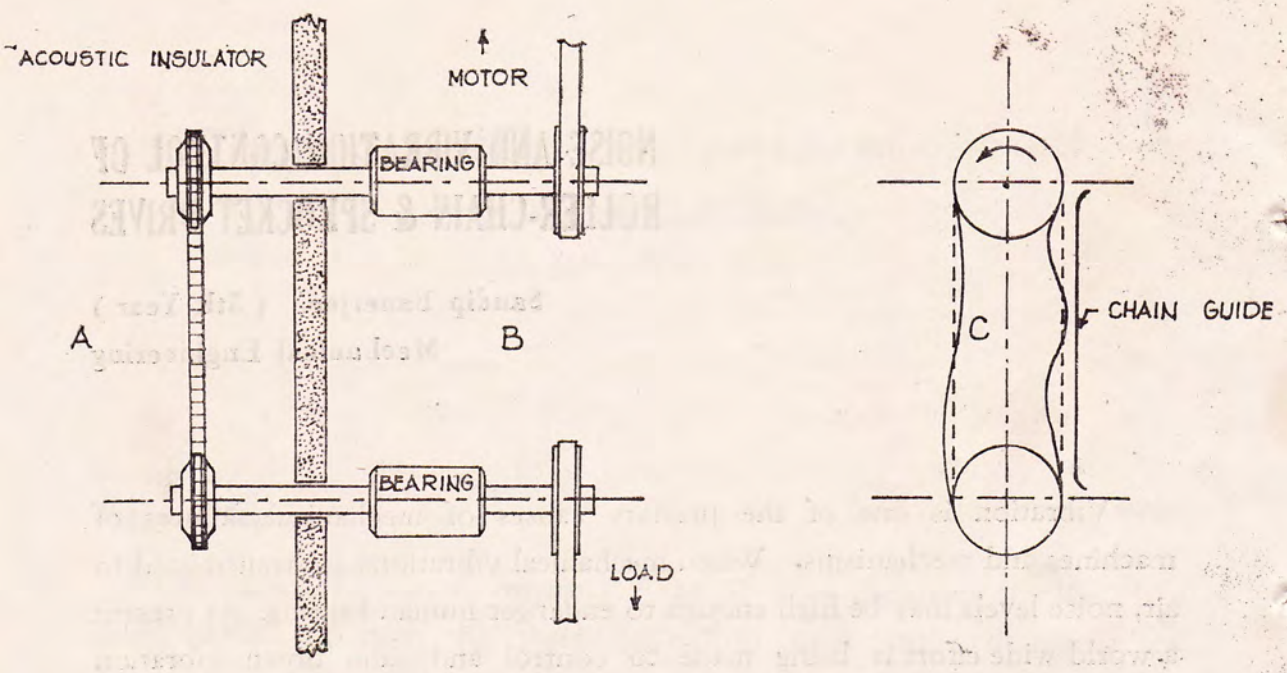


FIG.-A Three kinds of roller chain drive noise can be detected by placing microphones at points A, B and C Acoustic insulator isolates meshing noise from other noise.

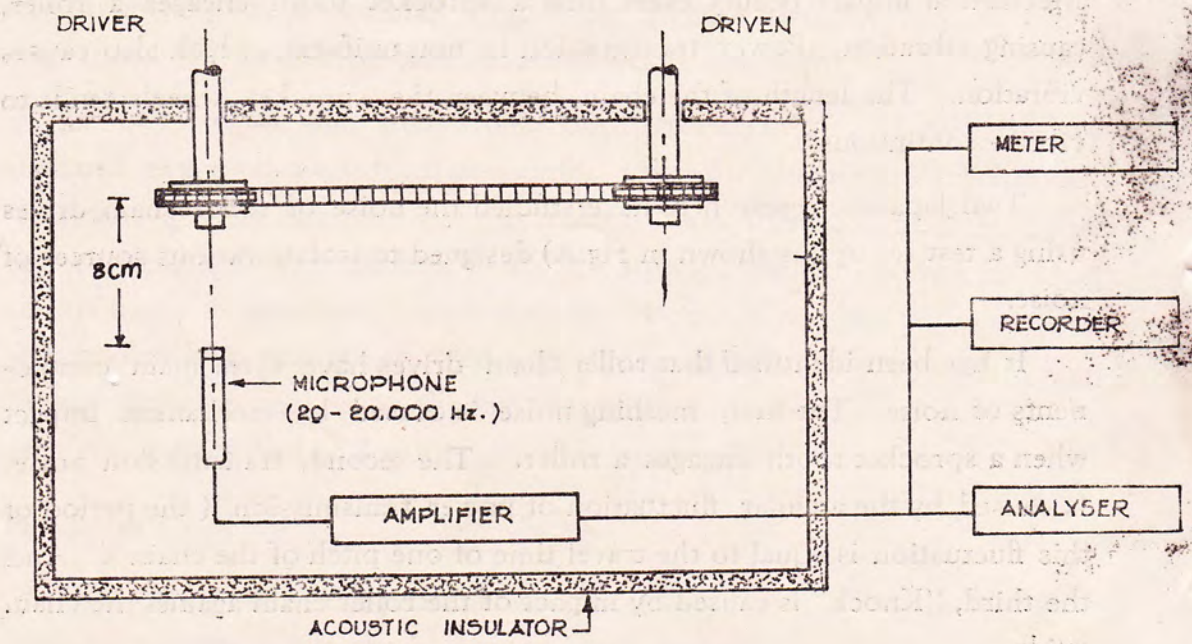


FIG.-B Experimental set up to measure meshing noise. Roller chain and sprocket wheels are acoustically isolated from other sources of noise to facilitate analysis of spectra.

Meshing noise tends to increase with vibration frequency. Elestic vibration of the sprocket wheel and its shaft, and elestic vibration of the rollers contribute to the overall meshing noise.

Transmission noise has a frequency exactly equal to the meshing frequency. It increases greatly when shafts, bearing and housing resonate with meshing frequency.

It has been found through experiments that noise caused by the fluctuation of angular transmission of the roller chainsprocket wheel system could be suppressed by increasing the compliance of the system. High speed movies showed that "Knock" can be reduced by reducing the slack in the rollar chain as much as possible.

Reducing meshing noise is a more difficult problems. Using a new test set-up (as shown in Fig.B) further experiment of meshing noise were made. Test results showed that noise levels can be reduced somewhat by lubrication. Noise increases steeply with sprocket wheel r. p. m. and roller chain pitch length, and increase somewhat with increasing initial chain tension.

Although meshing noise cannot be completely eliminated, some degree of meshing noise control is possible on the basis of the experimental results.

Thermo Mechanical Treatment of Steel

Sri Panchanan Bandyopadhyay
5th Year, Mech. Engg.

Introduction :

Thermomechanical treatment (T. M. T.), as the name implies, is a combination of both the thermal or heat treatment and mechanical treatment. As we all know, thermal treatment basically consists in annealing or normalising, followed by machining, then austenitising, held at that temperature for homogenisation for certain time, and subsequently cooled at various rates, such as, quenching, normalising etc. And the mechanical treatment consists of rolling, forging etc. These two, when combined, constitutes what is termed as thermomechanical treatment.

It has been seen that thermomechanical treatment of steel gives rise to high and very good mechanical properties. Actually, during the mechanical trearment a great amount of substructures are formed which bind the martensite and thus martensite exists in a strongly locked condition. Due to this fact, the structure becomes finely dispersed and this is the reason why it gives high strength coupled with improved ductility properties. The beauty of the process lies in the fact that with the attainment of such a high strength, a great deal of ductility can also be obtained.

Principles :

The principle of the process is quite simple and just the insertion of working treatment into the heat treatment schedule.

What is actually done is that the material, here steel, is austenitised first, held for some time for homogenisation and then quenched to a certain temperature, known as deformation temperature, at which the deformation is given by suitable mechanical treatment and then cooled. Then usual hardening and tempering follow.

Depending on the deformation temperature i.e. where and at which temperature, the deformation is given, the process can be of different types.

Process :

There are two basic methods of T. M. T. and they are :—

(1) High temperature thermomechanical treatment (H. T. M. T.)

and

(2) Low temperature thermomechanical treatment (L. T. M. T.)

The first method (H. T. M. T.) consists in deforming steel at a temperature above the point A_3 in the stable austenitic range, the degree of deformation varying from 20 to 30%. Quenching for hardening immediately follows the deformation to avoid the occurance of recrystalisation process. After hardening as usual, tempering (low temperature tempering within 100 to 300°C) is done.

The schemetic diagram, illustrative of the above process, is shown in Fig.—1.

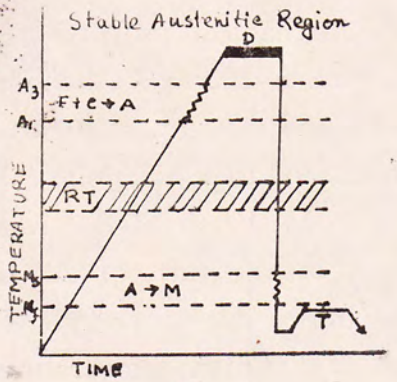


Fig.-- 1.

A – Austenite
D – Degree of deformation (20 – 30%)
F – Ferrite
C – Carbide
M – Martensite
T – Tempering
RT – Recrystallisation temperature

The second method (L. T. M. T.) consists in deforming steel, however at a temperature zone of relative austenite stability (about 400 to 600°C), the working temperature being above the M_s temperature but lower than the recrystallisation temperature. The degree of deformation ranges from 75 to 95% and hardening here also follows the working. In this process also low temperature tempering is done in the same region of temperature as in H. T. M. T.

The schematic diagram is shown in Fig.—2.

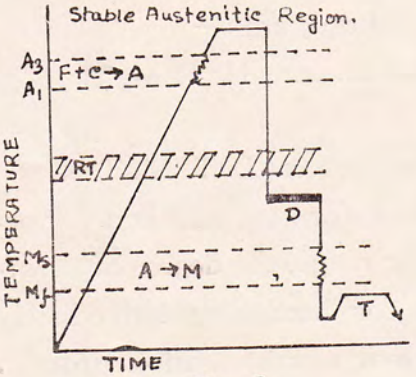


Fig.-2.

A – Austenite
D – Degree of deformation (75 – 95%)
F – Ferrite
C – Carbide
M – Martensite
T – Tempering
RT – Recrystallisation temperature

Another variation of the process of T. M. T. consists in working steel at the temperature zone of martensite transformation followed by usual treatments.

Mechanical Properties :

The T. M. T. gives rise to high and very good mechanical properties.

This treatment enables a very high strength, such as 200 to 300 kg/mm² to be obtained with good ductility such as 6 to 8% and thoughness such as 5 to 6 kgf-m/cm². The highest strength, around 260 to 300 kg/mm², is attained in the L. T. M. T. where as by the H. T. M. T. so high tensile strength cannot be obtained (obtained strength to the turn of 220 to 240 kg/mm²). This is expected because of the impossible of completely supressing at least some partial recrystallisation at that high temperatures encountered in the process (H. T. M. T.).

H. T. M. T. gives nevertheless, a much better as well as larger margin of properties including impact strength at room and still lower temperature and also reduces the cold-shortness threshold and the tendency to temper-embrittlement. Moreover, this process is more efficient and more economic because of the less power requirement for deformation.

Advantages & Limitations :

Like in any process, T. M. T. is no exception to having its own advantages in conjunction with its limitations.
The advantages are :—

(i) high strength; and

(ii) improved ductility with resultant high toughness properties. Its limitation—T. M. T. treated steels are not very suitable for welding purposes as it suffers loss through the weld joints.

Uses :

Becauses of the temendous strength and toughness of these steels, they are being used very widely for numerous purposes where these properties, in particular, are called for some of the examples are :—

(i) for air craft wing forging;

(ii) for rocket casings and related applications and

(iii) as forgings, stampings etc. for normal engineering structural purposes where they are required. Apart from this, they find may other applications in related aero-space industries. They are slowly facing the growing competition around them because of the advent of super strength steels as mentioned above and also of the newly coming in super alloys.

Further Improvement :

In dealing with T. M. T. treated steels in service it has been seen that this steel too suffers from a brittleness, though not appreciable normally, because of the presence of carbides therein.

This conception led to the development of a super strength steels like the marging steels to accouot for the brittleness and this development is followed by an intensive avalanche of new studies on still better and higher quality steels.

Conclusion :

T. M. T., as a whole, at present, is very well established, and still researches for developments in this field are going on throughout the world extensively.

In the perspective, T. M. T. has got a bright and prosperous future looming large in the horizon, irrespective of the fact that the competitors are on their way, so far as the economy is concerned.

STUDY ON THE APPLICABILITY OF WHITE CAST IRON

PRALAY CHAKRABARTI, [5th Year], Mechanical Engg.

Introduction :

White Cast Iron finds only limited directed applications because of its brittleness and poor mechanicability. It is mostly malleablised through heat treatment. In white cast Iron (W. C. I.), the carbide is present in massive form and if it can be broken down to disperse this uniformally, only then is it possible to counter the brittleness and incur good mechanical properties.

Recent reports suggest that the carbide net work can be broken down and dispersed by hot working. Russian workers[2] used hot forging in this field and got improved tensile properties. Japanee workers[3], however, used hot rolling.

The necessity of exploring the applicability of W. C. I. through this new field is strongly felt and hence this review, apart from the conventional malleablising through heat treatment of the same.

Composition :

The two W. C. I. samples are taken for the study-one of them plain and the other alloyed with Cr. The composition are as given in the Table-I.

Mechanical Properties :

The samples are made in slabs, one end forged while the other end unforged, and properly heat treated.

Hardness : The hardness values of both the samples in both the unforged and forged part are recorded and as shown in Fig.—1.

It can also be seen that with a fixed amount of deformation (by the hot forging) and with a particular composition, the hardness decreases from the unforged end to the forged end. This is clearly seen from the Table-II – which also shows that with a particular composition and with increase in amount of deformation, the hardness decreases.

Tool Properties : The hot forging of the W. C. I. has also been found to increase the machineability and hence makes possible the use of hot forged W. C. I. as tool materials – as this has been found to have quite good cutting properties which are manisfested in the following Table-III.

Structural :

The micro-structural study shows the amount of graphitisation more in the forged part than in the unforged one.

Discussion :

The Fig.—1. indicates that for a particular composition the hardness decreases more in the forged part than in the unforged part. In addition this also shows that for the alloyed composition the rate of fall of hardness is low – a fact which is quite expected of an alloyed composition under such conditions. Besides, with increases in deformation the hardness fallsdown.

The whole observation is quite in agreement with the fact that the hot forging breaks down the massive carbides into uniform dispersion, which clearly and exclusively accounts for the decrease in hardness from unforged part to the forged part. The lowering down of the hardness with increase in deformation also tallies with the fact that the more deformation continues to break down more and more massive carbides into uniform distribution throughout the matrix.

The tool properties can as well be explained in the light of what has been stated above. The uniform dispersion of the broken down massive carbides lowers the hardness, as shown above, resulting in higher machineability.

Table-III depicts these cutting properties and the hot forged and property heat treated W. C. I. (a particular way being to quench from 950°C and temper at 200°C for one hour) show fairly comparable tool properties, even to compete with H. S. S.

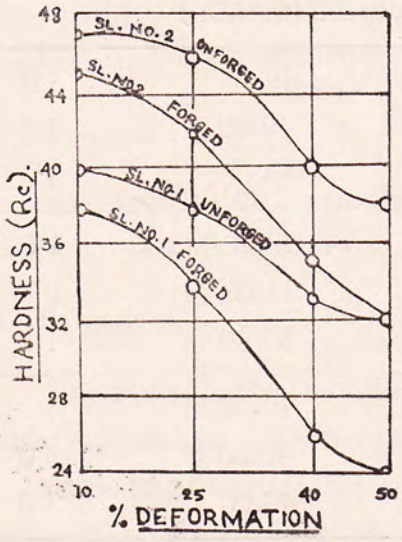
Finally, structurally when one analyse, he finds that amount of graphitisation is more in the forged part than that in the unforged one. This is again in conformity with the fact that breaking down of massive carbides occur with hot forging. It has been found, for the plain composition the volume fraction of graphite in the forged part is 15% and around 5% in the unforgee part, while that in the alloyed composition is 4% and 2% respectively.

Comments and Conclusions :

In perspective of the discussion we arrive at the following conclusions :

1. Hot working breaks down the massive carbides, prompts the graphitisation.

2. The properties discussed are quite satisfactory for its applicability and the alloyed W. C. I. shows improved properties undoubtedly, though not to that extent as is exhibited by the plain one.



3. Machine tools made out of this properly hot worked and heat-treated have good cutting properties.

Reference :

1. Trans. I. I. M., 33, (1980), pp. 467.
2. Kuchi Tanguchi, Imono, 47 (1975),5.
3. J. Wadworth and O. D. Sherby, Foundry Management and Technology, 106 (1978), 53.

TABLE – I.

Sl. No.	%C	%Si	%Cr	%Mn	%S	%P
1	2·31	1·4	–	0·55	0·06	0·06
2	2·42	1·3	1·85	0·54	0·06	0·06

TABLE – II.

% Reduction in thickness	Hardness in Rc after soaking at 950°C for 2 hours followed by air cooling.			
	Fofged		Unforged	
	Sl. No. 1	Sl. No.2	Sl. No. 1	Sl. No. 2
10	22	32	32	38
25	22	30	25	31
50	20	28	25	30

TABLE – III.

Stock Material	Tool Material	Feed (mm/rev)	Maximum possible cutting speed (m/min.)	Depth of cut (mm)
Grey Iron	Alloy – 1	0·1	49·00	3·0
	Alloy – 2	0·1	49 00	3·0
	H. S. S.	0·1	61·00	3·0
Mild Steel	Alloy – 1	0·1	33.00	1·0
	Alloy – 2	0·1	33·00	1·0
	H. S. S.	0·1	53·00	1·0
Low Alloy Steel	Alloy – 1	0·1	40.00	3·0
	Alloy – 2	0·1	40·00	3·0
	H. S. S.	0·1	40.00	3·0

PLASTIC GEARS & HYSTERESIS FAILURE

RANA BASU, 3-RD YR. M.E.

Thermoplastic gears cannot be viewed simply as metal gears cast in plastic. Although many plastic gear design techniques are derived from metal gear technology, plastic gears demand special considerations. Plastic gears have a number of attractive features. They generally are quite, durable, reasonably priced, and often can act without lubrication. In fact plastic gear design often requires attention to details that have no effect on metal gears.

The basic difference in design philosophy between metal and plastic gears is that metal-gear design is based on the strength at a single tooth, where as plastic gear design recognizes load sharing among gear teeth. In other words, plastic gear teeth deflect more under load and spread the load over a large number of teeth. In most applications, this load sharing increases the load-bearing capacity of plastic gears.

In general, the following step by step procedure will produce a good gear design when working with thermoplastic materials;

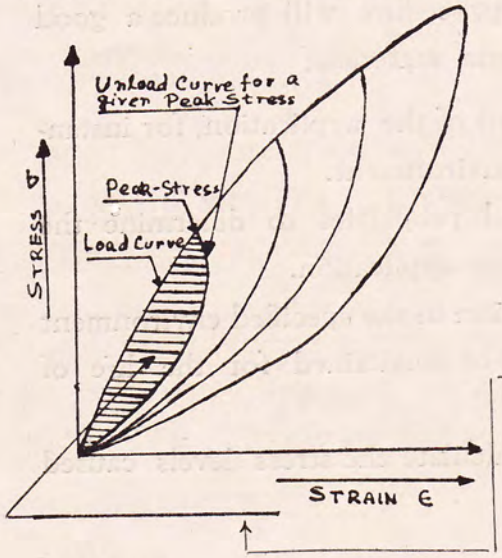
1. Determine the boundary conditions of the application, for instance, temperature, load, velocity, space and environment.
2. Examine the short term* material properties to determine the initial performance levels are adequate for the application.
3. Review long term* property retention in the specified environment to determine if the performance levels will be maintained for the life of the part.
4. Using the physical property data calculate the stress levels caused by the various loads and speeds.

5. Compare the calculated values with allowable stress levels and redesign if necessary to provide an adequate safety factor.

Inspite of the design considerations, if the plastic gears are run at high speeds, they are vulnerable to a type of failure that generally is not found in metal gears. The operating speeds and gear geometry may be such that heat buildup from hysteresis can exceed the rate at which heat is removed by conduction, radiation and convection. The resulting temperature increase can rapidly reach the point where the gears distort, fracture or even melt.

Previously, such features received little attention because the combination of gear loads and operating speeds rarely caused failure from hysteresis. But such failures are becoming more common as plastic gears are increasingly being used in high-speed devices such as printers and computer peripherals.

Heat build-up from hysterasis results from friction within a material as it deflects under load. The process can be represented on a stress-strain curve [Fig. a] as a loop formed by the load and unload cycle, with the load cycle reprsenting a higher stress value then the unload cycle for a given strain. The area within this loop represents the energy converted to heat.



Enclosed area represents Strain-Energy absorbed by the plastic as a result of Hysteresis.

The amount of heat generated by hysteresis increases as stress increases. For a given stress, the heat generated incre ases with an increase in temperature and an increase in loading rate. When hysteresis based failure occurs it is of a melting type rather than being a brittle failure. In the case of nylon, this failure mode was evident because of the way in which the material was pushed aside. The transparent area around the failure indicated melting and quick cooling.

At first, these failures were puzzling to analysts but eventually were traced to hysterisis heating. It became evident that if the heat transfer mechanisms were not adequate, the temperature of the gear would begin to rise. As temperature increased, the amount of heat generated with each cycle would increase, further loading the heat transfer system and causing additional temperature increases. This cascading action continued until melting of the gear teeth led to catastrophic failure.

Coping with high gear Temperatures :

There are two ways to cope with hysteresis heating. Eithea the rate of heat generation must be reduced or the rate of heat transfer must be increased. In either case, or by a combination of both,the gear tempeature can be stabilized. If it does stabilize, the gear will run indefinitely until stopped by genuine fatigue faliure.

Hysteresis heating can be redeced by several methods. The preferred way is to reduce the peak stress by increasing the tooth root area available for the required torque transmission. Another way is to reduce stress on the teeth by increasing gear diameter.

The use of stiffer materials in short using a material exhibiting less hysteresis in another way to improve the life of plastic gear. The most effective method to improve stiffness is through the use of Jillers, especially glass fibre.

The surrounding fluid whether air or liquid also has a substantial effect on cooling rates. If a fluid such as an oil bath is subtituted for air, the heat-transfer from the gear to the oil is usually about ten times that for transfer to air. The degree of agitation of the air or oil also affect heat-transfer by a like amount or more. In addition, heat transfer is increased if the cooling medium is cooled by a heat exchanger or by system design having a similar effect.

Analyzing for Thermal Balance :

The first step in designing to avoid hystersis induced facture is to establish the heat generated by the gear. For this purpose, it is necessary to have curves defining heat generated per cycle q_h/n, as a function of the peak tooth stress σ and the loading rats I. The rate of heat genaration q_h is calculated for a given σ and I by multiplying the heat generated per cycle by the gear speed.

The peak strees 'σ' can be calculated from hewis Equation for gear tooth bending strength,

$$\sigma = W_t/pFy$$

where, transmitted load W_t is,

$$W_t = 2T/D$$

Although the circular pitch 'p' is not always constrained in an application, it is usually selected on the basis of standard modulas or a series of standard diametral pitches. Factors such as contact ratio, gear motadibility, the tooth strength generally influence the selection of 'p'. Once 'p' is determined the hewis form factor 'y' can be found from tables in handbooks. The face width 'F' usually is selected on the basis of strength and space requirements.

Heat is dissipated from plastic gears primarily by conduction and convection. Gears with excellent heat dissipating properties consist of a ring of plastic gear teeth supported by a metal insert with a hub for mounting on shafts. For such gear designs, the primary heat transfer surfaces are at the gear teeth and the inside of the plastic ring which is in contact with the metal insert.

The rate of conduction heat transfer 'q_1' through the gear materials is calculated as,

$$q_1 = \Sigma \, (\Delta t / R_f)$$

And the rate of convection heat transfer 'q_2' calculated as,

$$q_2 = \frac{hA \, (\Delta t_{IN} - \Delta t_{OUT})}{\ln (\Delta t_{IN} / \Delta t_{OUT})}$$

For these heat transfer rate calculations, the heat transfer coefficient to the surroundings, thermal resistance and maximum operating temperature of the gear materials, and the maximum temperature of the cooling medium must be known.

If the thermal balance analysis indicates that the rate of heat generation is greater than the rate of heat dissipation, then the plastic gears will fail from overheating. To ensure that the gears will not fail, the heat dissipation rate must balance the heat generation rate.

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* In gear design the two most important short term properties are tensile yield strength end flextural modulus.

Long term properties, on the other hand, refer to design data showing changes in material performance with time. These property changes usually are caused by extended loading, high temperatures, or other severe environmental conditions.

Solar energy and its versatility

Kalyan Mukher ee

3rd Year, Mech. Engg.

The great demon sun is the source of all forms of energy. Energy is at present derrived from four primary sources : petroleum, natural gas and natural – gas liquids, coal and wood But the supplies of these common sources (except wood) are finite. Their lifetime is estimated to range from 15 years for natural gas to 300 years for coal. Now what will happen to the modern world and the mankind after the exhaustion of this nonrenewable, nonrecoverable energy source fossil fuel ? Actually, the growing public awareness of fossil fuel scarcity, the sky-reaching price and the diffculties in getting oil from oil-rich countries are providing interests in long-term and permanent energy sources. The most significant among these is, solar energy. The amount of solar energy intercepted by the planet earth is 170 trillion kw. of this amount 30% is reflected to space, 47% is converted to low-temperature heat and radiated to space and 23% powers the evaporation cycle of biosphere. The amount of the sun's energy in ercepted by earth is only one thousandth of one millionth of the total energy released by the conversion of 4 million tons of hodrogen to helium in the sun.

The first person to use the sun's energy on a large scale was Archimedes, who reputedly set fire to an attacking Roman fleet at Syracuse in 212 B.C. By 1700 diamonds had been melted and by the early 1800-s heat engines were operated utilizing solar energy. In the early twentieth cen ury solar energy was used to power water distillation plants in Chile and irrigation pumps in Egypt. The most prominent applications of solar energy are for space heating and cooling, water heating and air heating for industrial drying purposes. It is becoming clear that solar devices will economically be feasible in near future, as an alternative to conventional fuel system.

Solar energy is transmitted from the sun through space to the earth by electromagnetic radiation. It must be converted to heat before it can be used in practical heating or cooling systems. Solar energy collectors (viz. Nonconcentrating or flat, and Concentrating) are the devices used to convert sun's radiation to heat. The collectors usually consist of a surface that efficiently absorbs radiation and coverts this incident flux to heat which raises the temperature of the absorbing material. A part of this energy is then transferred from the absorbing surface by means of a heat-transfer fluid (such as air or water). Methods of solar energy collection range from active, mechanical, solar thermal collectors to photoelectrical devices to windmills to fully passive collection systems. What we normally call as "Green house effect" comes from the fact that, anything that is transparent to visible light and opaque to infra red wavelengths longer than 3 microns (1 micron $=10^{-10}$ cm). Thus glass the front cover of collectors-admits solar light to enter into it where it is turned into heat. The heat inside steadily increases as the solar radiation falls on the collector and reaches the equilibrium temperature. The prime attention of solar scientists is to block the heat losses to increase collector efficiency. To achieve the maximum efficiency, the aim of solar engineers should be to increase the absorptance and decrease the emittance as low as possible. The absorptance of the surface is related to its cleanliness and roughness whereas the emittance depends upon the temperature of the surface. Selective absorber coating, the no. of plates used (single, double or tripple plate) incidence angle, collector-orientation and other factors affect the collector efficiency.

The food manufacturers are looking more closely than ever at their methods of processing in order to judge where economy can be gained without affecting product quality. Ths solar air pre heater for spray drying of milk powder installed at Amul Dairy (Gujrat) is described here. This solar air pre heater is the first of its kind in India, perhaps in the world.

In the set up in Amul Dairy a roof measuring about 28 m. × 11·4 m. has been converted to a collector with minor changes. A roof of asbestos sheets inclined at 15° to the horizontal, covers the powder plant. To minimise the cost of installation of this device the same roof has been converted into a solar collector by introducing a series of panels. The dimension of each panel is 1m × 1m × 3m. To increase the absorption of the collector the roof has been painted with Ferrotol (black chimney paint) which has a minimum reflectance. The projections of asbestos sheets maintain air gap between the glass and asbestos sheets and channels in these projections are used to direct the air flow. At the end of each set of 12 channels, headers are connected to the main channels to collect and change the direction of air. The last two headers are connected to the main duct to suck the heated air from the heater. This preheated air is further heated upto 170°C by means of conventional fuel system air heater and then used for powder manufacturing. An average temp. rise of 52°C has been observed during the sunny days. Air flow rate is 14450 kg/hour. The collected air is drawn through solar collector by means of a blower installed inside the building where the spray plant is located. To increase the heat transfer rate, turbulence of air is created by placing iron filings and scraps inside the panels. The efficiency of solar collector was calculated to be 70%.

A solar paddy drier of one tonne per day capacity has been designed, fabricated and tested successfully by the Department of Mechanical Engineering, Annamali University, India in 1976. This is a roof-cum-flat plate collector and first of its kind in India. The gross area of the collector is 50·75 m^2 with a plinth area of 44·5 m^2. The collector can be used for storing and other purposes in addition to the bin drying. The absorber plates use plain galvanised iron sheets with black board paint covered by glass 3mm thick. The entire set-up is insulated by using 5m thick layer of fibre glass. To obtain a better performance for year-round operation the

slope of the collector is to be kept at 10° to the horizental, facing south as the latitude at Annamali Nagar, is 11°.

The drying of wet grains following harvest consumes large quantities of energy, much of it in the form of fosile fuel heat to increase the drying air temperature. Recently, research efforts on applying solar energy to grain drying have been directed to modify existing drying systems by using solar collectors installed on the sides of grain drying bins. The prototype grain dryer considered here has a unique feature in that the dryer unit itself serves partly as a solar collector.

The prototype solar grain dryer (Raleigh, North Carolina) consist of a quenset shaped chamber made of tedler coated clear currugated fibre-glass and of dimensions 7·7 m wide, 4·0 m high and 8·5 m long. The clear fibre glass produces 'green house effect' inside the chamber which is situated on a flat concrete slab and black wall foundation. Inside the chamber there are two cylindrical dryer units each 2·2 m. in diameter, 4·6 m. long and has a capacity to hold approximately 3-4 tons of pea-nuts. During drying the drums rotate periodically (2 revolution/hour) in order to maintain uniform drying of pea-nuts and a fan blows atmospheric air inside the chamber. The drying of pea-nuts takes place by moisture loss to the hot air passing over them. The black surface of the drum also acts partly as a solor collector, being heated by the absorption of solar radiation incident upon it and dissipiates the heat both into the air in the chamber and to the pea-nuts. In India (Annamali Nagar) a solar heater of flat plate collector type was installed in 1975 for drying parboiled paddy. It can be used for drying wheat, paddy and other cereals.

Improved solar drying of food grains and other agricultural products is a feasible project that can be intensively practised in rural areas so as to save fossil fuels and food grains which are now lost due to open yard sun drying. It can be safely said that the energy saved in a day for 50 sq. m. collector is equivalent to about 30 litre of furnace oil in an industrial application.

The convertion of saline or brackish water to distilled water through the use of solar radiation is found to be most practical particularly in those situations where naturally available fresh water supplies are not available, or when available, need to be supplemented. In many villages and countries like Nigeria, Israel the ground water is saline; the best and cheapest way is to use solar energy and get distilled water to tide over the scarcity of water. The distilled water can be profitably used in science laboratories, petrol pumps, hospitals and in rural areas to produce potable water. Solar distillation units have been extensively studied and deployed on a moderate scale.

The existing large scale desalination plants all over the world are fossil fuel fired and 80% of them are of Multi Stage Flash Evaporator (MSF) tupe. With the fossil fuel prices spiralling up it becomes imperative to look at new methods of solar distillation. With this in mind a scheme is, therefor, outlined for large scale desalination of sea water using solar energy for castal desert of India. A scheme is proposed to desalinate sea water using solar energy for the Thar Desert of India. To solve the problem of fresh water scarcity and to grow food, vegetables in those regions, desalination of sea water for supplying fresh water should be done on a large scale. The scheme envisages bringing about $2{\cdot}16 \times 10^5$ m^3 of sea water every hour in three 3·05m. diameter concrete pipes to the "Solar field". The proposed location of this field in the Thar Desert is about 80km. from the Arabian sea. The sea water is heated from 15·5°C to 54·4°C at 2p.m. on a typical June day by passing through the heat exchangers of 20 stage MSF evaporator.

This preheated water is again heated to about 60°C in the "Solar field" which consists of 9600 tubular concrete collectors. Water at 60°C is then flash evaporated in the desalination unit to yield $1{\cdot}36 \times 10^4$ m³/hour for a typical June day a 2p.m. An approximate total cost analysis shows that water from solar system is cheaper than that obtained the MSF fuel fired plant.

Direct solar-energy conversion to produce electricity through the photovoltaic effect is one of the most attractive means of utilising solar energy. At present, two types of semiconductor solar cells are at a stage of development to permit a reasonable analysis of their potention cost. One of these is based on the single-crystal solar cell which have been used to generate electric power for space vehicles and satellites. An experimental irrigation pumping installation has been set up near Mead, Neb., in which 120000 individual cells can produce 25 Peak kw under bright sunshine. But the high cost to make single crystals for silicon solar cell conversion system is the major problem. To reduce the cost of photovoltaics, single crystal silicons are produced in the form of long ribbons, which do not require very expensive operations to produce the jewel-like individual cells. Owing to the high cost of silicon-cells, the thin-film cadmium sulphide cell is very attractive. The active part of this cell is a thin (20-μ) polycrystalline film of cadmium sulphide onto which an even thinner (·2μ) layer of copper-sulphur compound is grown. The cost analysis as done by E. I. Dupont Comp. shows that these cells can be produced at $ 15/m² for large areas. But the efficiency of cadmium sulphide cells is only 5% and it is not even known whether the efficiency can be increased or not. Consiberably more research and developments are required before it can be as certained whether the cost of producing photovoltaic direct solar energy convertion systems can be come economically competitive or not.

Solar heating of buildings will be the first significant application in the

latter twentieth century. The technology is now developed, the systems are known to be viable, and the costs of solar heating are competitive with some conventional fuels in many parts of United States. Any solar heating systems consists of five major components : — 1. Collector 2. Storage 3. Auxiliary heater 4. Distribution system (e.g. radiators, forced air systems) 5. Controls and flow devices (e.g. fans, pumps).

Solar cooling of buildings represents a potentially significant application of solar energy for air conditioning in most sunny regions. Solar cooling technology is not as advanced as solar heating technology. It is important to note here that the periodicity and intermittance of solar energy incident on a collector require the use of a conventional (auxiliary) back up system. The size and cost of the total system depend not only on the solar energy collected but also on storage facilities. In a solar assisted heat pump system designed both to heat and to cool a buildlng, two general modes of operation are possible : — (a) The solar heating system and the heat-pump system may be seperate (b) The two systems are combined and a solar collector assists in reducing the amount of heat that must be supplied by the compressor when heating the building. Obviously the second arrangement is more efficient.

Solar water heating is the direct use of solar energy that has been practiced most extensively during the last two decades. It is the most viable of all low temperature solar energy applications. It is being widely used because the initial investment is small and the system is used throughout the year. To provide heat during long, cloudy periods, an electrical immersion heater can be used as a back up for the solar system. A non-freezing fluid should be used in the collector circuit. Sometimes, a collector with absorber plates is coupled to an insulated storage tank containing a limited quantity of water. The solar collector is generally placed on the roof of the buildings receiving solar heat and water is circulated by thermosyphon system.

Solar cabinet dryer is another example of solar energy application. In the solar cabinet dryer, products are subjected to direct drying by natural circulation. It has a common space for collecting solar energy and drying the product. Such dryers are easy to mtnufacture in villages and can be used for drying fruits, vagetables, pickles, chillies, corns and pappeds. Losses due to birds, squirrels etc. and contamination due ro dirt, smoke are completely eliminated.

Solar coal gassification is potentially an attractive chemical process. The coal can be gassified by reacting with steam (or Co_2) in the focal zone of a solar central receiver plant. Because, the coal-steam reaction is endothermic the product gas has greater heating value than that of coal. The necessary energy to drive the endothermic reaction is provided by focussed solar energy. Solar energy is thus converted into chemical energy and at the same time coal is gassified. This process has dual attractions of upgrading the coal to a more utilised form of fuel and of chemically storing solar energy. Such a reduction in coal usage in a gassification process reduces many environmental problems associated with the use of coal. In addition, a major cost abvantage is achieved by substituing solar energy for "expensive" oxygen-coal energy normally used in the production of medium-Btu gas.

Anotner useful application of solar energy is to reduce Co_2. It is thermodynamically possible to decompose Co_2 to carbon and oxygen by means of thermochemical cycles analogous to cyclic proccsses for decomposing water. Highly concentrated solar energy can supply necessary energy at temperature that permits short efficient cycles. The reduced carbon can be converted to fuels that are dense, convenient and require no major changes in the consuming sector of the economy. In addition to continuous use of fossil fuel, there are great difficulties connected with the environmental hazards of mining, suphur pollution and Co_2 built up in the atmosphere as a result of fossile fuel use. There are several thermodynamical

ways in which solar energy could be used to decompose Co_2 into C or Co and O_2 and thereby providing a new source of carbon based fuels which do not contribute to the problems above. These cycles of decomposing Co_2 seems to be suggested by Dorner and Keller. The reaction of a cadmium-based cycle is shown here.

$$2Cd + Co_2 = 2CdO + C \quad (600k)$$

$$\Delta H = -32{\cdot}6 \text{ k.cal.}$$

$$2CdO = 2Cd + O_2 \quad (1900k)$$

$$\Delta H = +168{\cdot}5 \text{ k.cal.}$$

The efficiency of the cycle is 56%.

There are also other applications of solar energy. The production of electricity by solar energy based on concentration of solar rays onto a boiler to produce steam directly or indirectly through some form of heat exchanger or storage media has been the subject of many studies and projects. In solar powered lift pump, solar milk cooker, solar wax melter solar eneagy can be utilised.

The main drawback of solar energy source is that it is not available at night and during periods when the sun is obscured by clouds. So a means of providing heat on a continuous basis from this intermittent source is required. For this purpose, many ways of thermal energy storage have been developed.

The field of solar energy utilisation is undergoing rapid and accelarating changes. Many new ideas and concepts are under active and vigorous development. So it is necessary for architects, engineers, planners and installers of solar systems to be in close touch with the developments in this field by keeping themselves intimate with both trade publications and technical literatures.

FACTS AND FALLACIES

SANDIP BANERJEE AND MANGALMOY BISWAS
5th YEAR, MECHANICAL ENGINEERING

We Engineers, use numbers in every step of our life without knowing how astonishing and exciting they could be. In this article we intend to present the readers with some interesting and startling results of numbers.

1. Addition is the reverse of multiplication in the following :
   (i) $9+9=18$; $9\times 9=81$
   (ii) $24+3=27$; $24\times 3=72$
   (iii) $47+2=49$; $47\times 2=94$
   (iv) $497+2=499$; $497\times 2=994$
2. Addition is equal to multiplication when the two figures to be added or multiplied are of the form 'n' and 'n/(n − 1)' where 'n' is any natural number greater than one.
   i.e. $n+n/(n-1)=n\times n/(n-1)$
   putting $n=3$, we get : $3+1\frac{1}{2}=3\times 1\frac{1}{2}=4\frac{1}{2}$
   Now verify for yourself by putting n = any natural number > 1.
3. Subtraction is the same as multiplication when the two numbers to be subtracted or multiplied are of the form 'n' and 'n/(n+1)' where 'n' is any positive integer including zero.
   i.e. $n-n/(n+1)=n\times n/(n+1)$
   putting $n=2$: $2-\frac{2}{3}=2\times\frac{2}{3}=1\frac{1}{3}$
   Now verify for yourself for any n satisfying the above stated condition.
4. Multiplication or Repetition :
   Choose any number between 1 and 9, and multiply it by 9. Multiply the answer thus obtained by 12,345,679 and you will get your chosen number repeated 9 times.

Let us choose 9, then $9 \times 9 = 81$ and
$12,345,679 \times 81 = 999,999,999$.
Choosing 4 we get $9 \times 4 = 36$ and
$12,345,679 \times 36 = 444,444,444$.

5. Let us multiply any number by 9. The digits of the result will always total 9. For example –
   (i) $9 \times 12 = 108 \rightarrow 1+0+8 = 9$
   (ii) $9 \times 845 = 7605 \rightarrow 7+6+0+5 = 18 \rightarrow 1+8 = 9$
   (iii) $9 \times 213 = 1917 \rightarrow 1+9+1+7 = 18 \rightarrow 1+8 = 9$

6. Choose a number with unequal digits. Reverse the digits to form a new number and get their difference. The digits of this difference will add up to 9. For example –
   (i) Take the number 74. The number formed by reversing the digits is 47.
   So, $74 - 47 = 27 \rightarrow 2+7 = 9$
   (ii) For 132 the reverse number is 231
   So, $231 - 132 = 99 \rightarrow 9+9 = 18 \rightarrow 1+8 = 9$
   (iii) For 7341, the reverse number is 1437.
   So, $7341 - 1437 = 5904 \rightarrow 5+9+0+4 = 18 \rightarrow 1+8 = 9$
   and so on for the numbers with higher digits.

7. Choose any number and re-arrange the digits to form new numbers. The difference between the numbers adds up to 9. For example –
   (i) Let us take the number 132. The new numbers are 123. 213, 231, 312 and 321.
   Now, $132 - 123 = 9$
   and $231 - 123 = 108 \rightarrow 1+0+8 = 9$ etc.
   (ii) Taking the number 1234 we get the new numbers 2314, 2341, 2134 etc.

Now, $2314 - 1234 = 1080 \rightarrow 1+0+8+0=9$

and $2341 - 2134 = 207 \rightarrow 2+0+7+=9$

The rule is even valid for a number of 'n' digits in which 'n−1' digits are same or repeated, where, n is any position integer greater than 1.

8. Take any number consisting of nines, for example 9,999,999 and multiply it by any number between 1 and 9. In the answer the sum of the first and last digits is 9, all other digits being 9.

For exemple –

9,999,999	9,999,999
× 8	× 5
79,999,992 (7+2=9)	49,999,995 (4+5=9)

You will further notice that the sum of the total digits of the result will always total 9.

9. Choose any two digited number between 14 and 89 in which the left hand digit is less than the right hand one. Put the difference of these two digits to the right of the number, thus forming a number of three digits. Divide this three digited number by 11. To the quotient so obtained add the left digit of the original two digited number and you will get back the original number with which you have started.

Let us choose 79, then 9 − 7 i.e. 2 is placed after 79 forming 792.

Then $792 \div 11 = 72$ and $72+7=79$.

Choosing 27 we get three digited number 275 (because $7-2=5$), then $275 \div 11 = 25$ and $25+2=27$.

10. Here is again an astonishing result :

Multiply 12,345,679 by 999,999,999 and you will get in your answer the number 1 to 9 arranged first in the ascending order and then in the descending order. Your answer will be 12,345,678,987,654,321.

11. Let us square a number consisting of once (11111 ... ... upto n times) where n is a positive one-digited number i.e. n may acquire any value

between 1 and 9. The method is quite simple. Write the numbers 1, 2, 3, 4, ... 9 first in the ascending order upto n and then in the descending order upto one and that will be your answer.

e. g. the square of 11 is 121 (here n = 2)

the square of 1111 is 1234321 (here n = 4)

similarly,

$(1111111)^2 = 1234567654321$ (here n=7)

$(11111111)^2 = 12345678987654321$ (here n=9)

and so on.

12. Our next attempt is to square a number consisting of threes like (333 ... ... upto n times) where n is any positive number. The answer will be of the form (A) 0 (B) 9.

Now to fill in the gaps (A) and (B) put n – 1 ones in gap (A) and n – 1 eights in gap (B) and you will get your answer.

e. g. the square of 33 is 1089 (here n=2)

Similarly $(3333)^2 = 11108889$ (here n=4)

$(3333333)^2 = 11111108888889$ (here n=7)

$(33333333333)^2 = 1111111111088888888889$ (here n=11)

13. Let us square a number consisting of sixes like (666666 ... ... upto n times) where n is any positive number. The answer will be of the form (A) 3 (B) 6.

Now just fill in the gap (A) with n – 1 fours and the gap (B) with n – 1 fives and the number thus formed will be your answer.

e. g. the square of 66 is 4356 (here n=2)

Similarly $(6666)^2 = 44435556$ (here n=4)

$(6666666)^2 = 44444435555556$ (here n=7)

$(66666666666)^2 = 4444444444355555555556$ (here n=11)

14. Now let us try to raise a figure consisting of nines like 999 .. .. n times ... ... 9 to the power m. To find the answer, we need to know only the value of 9^m and then put the digits of 9^m = wxyz ... ... (say) in the

following format :

(A) w (B) x (C) y (D) z ... ...

To field in the gaps (A), (B), (C), (D) etc., we put $n-1$ nines in alternate gaps [A], [C] etc. and $n-1$ zeroes in alternate gaps [B], [D] etc.

For example–

Let us spuare the number 999999. We need to know $9^2=81$. Putting 8 and 1 in the format we get [A] 8 [B] 1. Then filling [A] by 99999 and [B] by 00000 the answer comes to 999998000001.

Let us cube the number 9999. We are to find $9^3=729$. Putting 7, 2 and 9 in the format we get [A] 7 [B] 2 [C] 9. Then replacing [A] and [C] by 999 and [B] by 000 we get 999700029999 which is the answer. Similarly,

$(999)^5 = 995009990004999$ [with $9^5 = 59049$]

$(99999)^4 = 99996000059999600001$ [with $9^4 = 6561$]

Try with some more examples and verify whether the formula is correct or not.

15. Here are eight numbers with these amazing properties :

[i] The sum of the first four = The sum of the last four

[ii] The sum of the squares of the first four = The sum of the squares of the last four.

[iii] The sum of the cubes of the first four = The sum of the cubes of the last four.

The numbers are 2, 8, 9, 15, 3, 5, 12, 14

Illustra ions :– $2+8+9+15 = 3+5+12+14 = 34$

$2^2+8^2+9^2+15^2 = 3^2+5^2+12^2+14^2 = 374$

$2^3+8^3+9^3+15^3 = 3^3+5^3+12^3+14^3 = 4624$

Here are another set of numbers having additional property that the equality is true in the mirror : 1181, 1811, 8188, 8818, 1118, 8111, 1888, 8881.

Illustrations :-

$1181+1811+8188+8818 = 1118+8111+1888+8881 = 19998$

$(1181)^2 + (1811)^2 + (8188)^2 + (8818)^2 = (1118)^2 + (8111)^2 + (1888)^2 + (8881)^2 = 149, 474, 970$

$(1181)^3 + (1811)^3 + (8188)^3 + (8818)^3 = (1118)^3 + (8111)^3 + (1888)^3 + (8881)^3 = 1, 242, 200, 007, 576$

Isn't it amazing ?

16, Lightning Addition :

Series
1
1
2
3
5
8
13
21
34
55
89
144
233
377
610
987
1597
2584

Tell your friend to underline any of the numbers of the series and in little or on time you can tell the sum of the numbers above the line. Tell him that he should not underline the last two numbers.

The calculation is very simple and is to be done in this way – Subtract 1 from the second number below the line and this will be your answer. Example – If 233 is underlined then your answer should be 610 – 1 = 609.

You may extend the series up to many terms as you like, keeping in mind that the last two numbers are not to be nuderlined. The formula is, add the last two numbers and get the next number. e.g. if the series is supposed to be upto 144, then the next number is 89+144 =233, the number next to it is 144+223= 377, the number following 377 is 233+377=610 and so on. The series thus obtained is known as "Fibonacci's Sequence".

17. Let us square a number ending with 1. Multiply the number following the one to be square by the number obtained by eliminating the last

digit of the number under consideration. Place 1 on the right side of the product and you get the result. Some examples are–

$11^2 = 121$ [$12 \times 1 = 12$]

$21^2 = 441$ [$22 \times 2 = 44$]

$31^2 = 961$ [$32 \times 3 = 96$] ... ... and so on.

18. To square any odd number ending with 3, multiply the next number ending with 6 (for example 16 and 26 for 13 and 23 respectively) by the number obtained by eliminating the last digit of the said number, and put 9 by its side to get the result. For example –

$13^2 = 169$ [$16 \times 1 = 16$]

$23^2 = 529$ [$26 \times 2 = 52$]

$33^2 = 1089$ [$36 \times 3 = 108$] ... ... and so on.

19. Finding the square of numbers ending with 5 is even easier. Eliminate the last digit of the number and multiply it by the following number. Put the number 25 after the product obtained which gives the result. For example–

$15^2 = 225$ [$1 \times 2 = 2$]

$25^2 = 625$ [$2 \times 3 = 6$]

$35^2 = 1225$ [$3 \times 4 = 12$] ... ... and so on.

20. In finding out the square of an odd number having 7 as the last digit the following rule is to be followed. Deduct 3 from the original number and multiply the number thus obtained, by the number, immediately following the number obtained by suppressing the last digit of the original number. Place 9 by the side of the product and get the result. Some illustrations are–

$17^2 = 289$ [$(17-3) \times 2 = 28$]

$27^2 = 729$ [$(27-3) \times 3 = 72$]

$37^2 = 1369$ [$(37-3) \times 4 = 136$] ... ... and so on.

21. For squaring a number ending in 9, multiply the number preceeding that under consideration, by the number following the one, obtained by eliminating the last digit of the said number. The digits of the product followed by 1 gives the result.

For example –

$19^2 = 361$ [$18 \times 2 = 36$]

$29^2 = 841$ [$28 \times 3 = 84$]

$39^2 = 1521$ [$38 \times 4 = 152$] ... ... and so on.

22. A Formula :

And at last a formula which comprises all the formulæs for volumes of regular solids, if the areas of their cross-sections can be found out easily, This formula is the "Prismodial Formula" and it reads

$$v = [\,(B+4M+T)/6\,] \times h$$

where, v, B, M, T and h are the volume, areas of bottom, middle and top cross-sections and height respectively.

As an example take the sphere –

$B = T = 0, \quad M = \pi r^2, \quad h = \text{diameter} = 2r$

$v = [\,(0+4\pi r^2+0)/6\,] \times 2r$

$= \frac{4}{6} \pi r^2 \times 2r$

$= \frac{4}{3} \pi r^3.$

STUDENTS, WHO FEEL SHY TO COME IN THE FRAME

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Dipankar Samanta
Subrata Sarkar

PHOTOGRAPHS

" When days are long and sunny
The flower of youth is blown
We waste our parents' money
And time that is our own."

OUR FUTURE MAKERS

Sitting (from Left to Right) : Prof. R. K. Ghosh, Prof. S. P. Sen, Prof. B. K. Dutta, Prof. D. N. Roy Prof. N. R. Chakrabarty & Prof. P. Pal.

Standing (Left to Right) : Prof. S. Barua Choudhory, Prof. A. Bose & Prof. A. K. ~~Chakrabarty~~ Chatterjee

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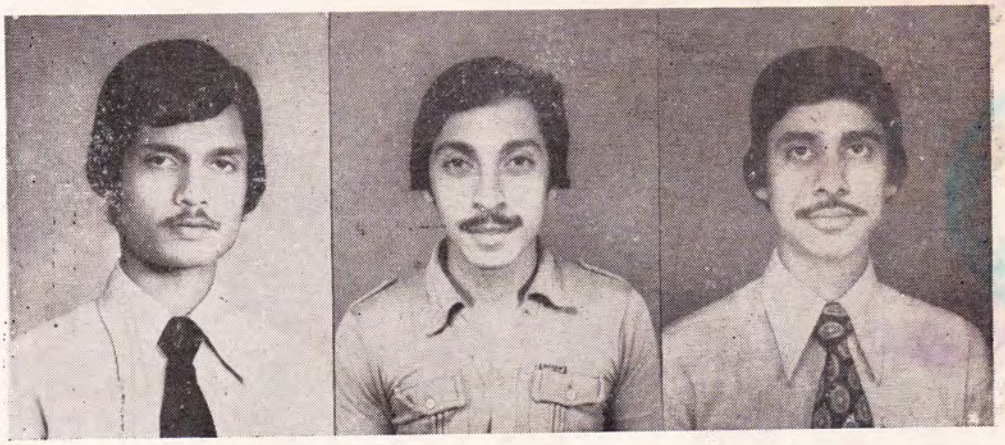

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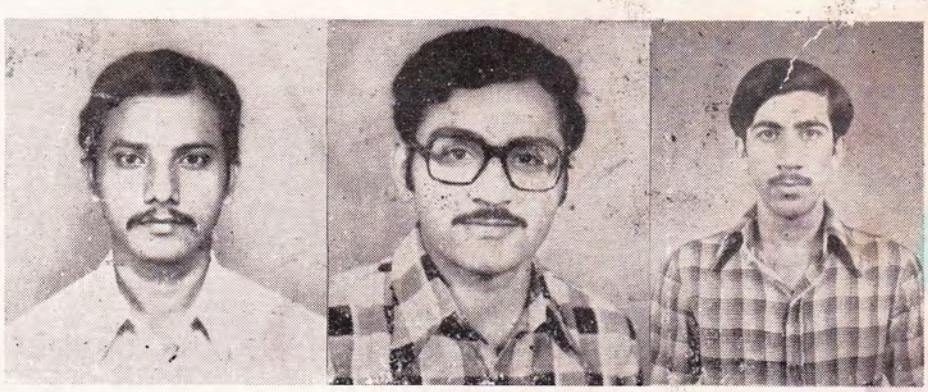

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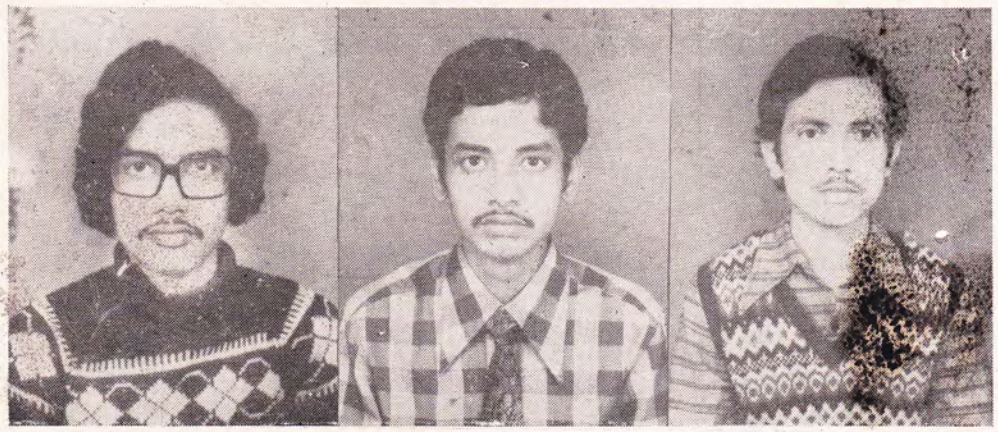

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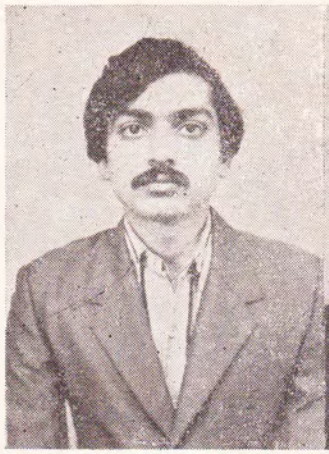

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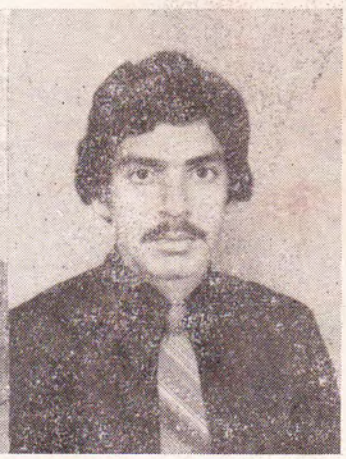
OF HIS HOMESICKNESS.

Manas Kumar Samanta



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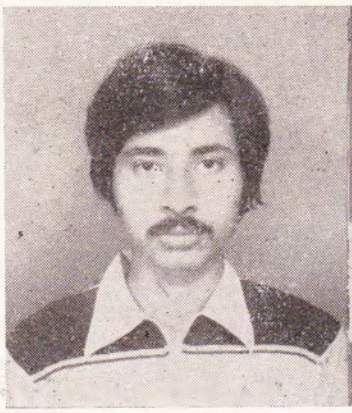
Sukanta Dey Roy



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NEWS FROM OUR DEPARTMENT

It is a great pleasure to know that Prof. Shyama Pada Sen, one of the senior professor of our department has taken over the charge as the Head of the Department from the 16th April, 1981. He took over from Dr. D. N. Roy, who was the H. O. D. for the last two years, and has served the Dapartment with great responsibility. We convey our hearty welcome to our new Head of Department Prof. S. P. Sen. and wish him success in his new chair.

We feel heavy; our hearts fill with great sorrow. One of our most beloved and senior professors of our department and also of our college Prof. Bhupal Krishna Dutt is retiring. It is a great loss for us, the student community; as Prof. Dutt had acquired the rare distinction of conquering the heart of innumerable students with his eloquoent style of teaching, his witful sense of humour and his very powerful idealism. He was the Head of Department for a long period. His keen interest in all sorts of student activities, especially in the games and sports made him so much popular among the students. After serving the college for the last three decades, he is stepping into a new life. We all, from the core of our hearts wish him a very healthy and peaceful retired life.

Prof. R. K. Ghosh has been honoured with "Doctorate" degree by The Calcutta University, under the guidance of Dr. A. K. Seal, Principal of our College. – Congratulations.

It has been very heartening to know that two of our young and prospective professors of the Department namely, Prof. T. K. Roy and Prof. A. K. Das are persuing Doctorate Degree in Quality Improvement Programme at I. I. T., Kharagpore. We are sure that their success will assure the enlightment of the Department with a fresh spart.

Prof. A. K. Chatterjee, is persuing his "Doctorate", on the subject of "Fluid Mechanics" under the guidance of Dr. D. N. Roy.

Our new companions in the workshop – five lathe machines, four modern shaping machines, one sophisticated milling machine. The workshop is being powered during load-shedding by a newly installed 50 k.w. Gen-set.

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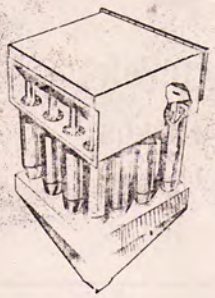

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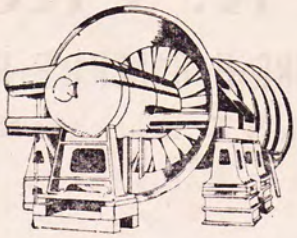

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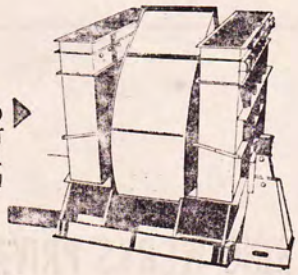

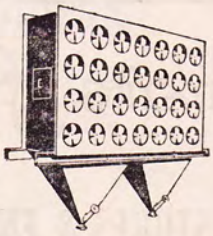

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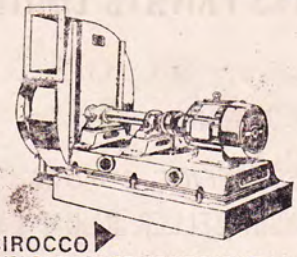

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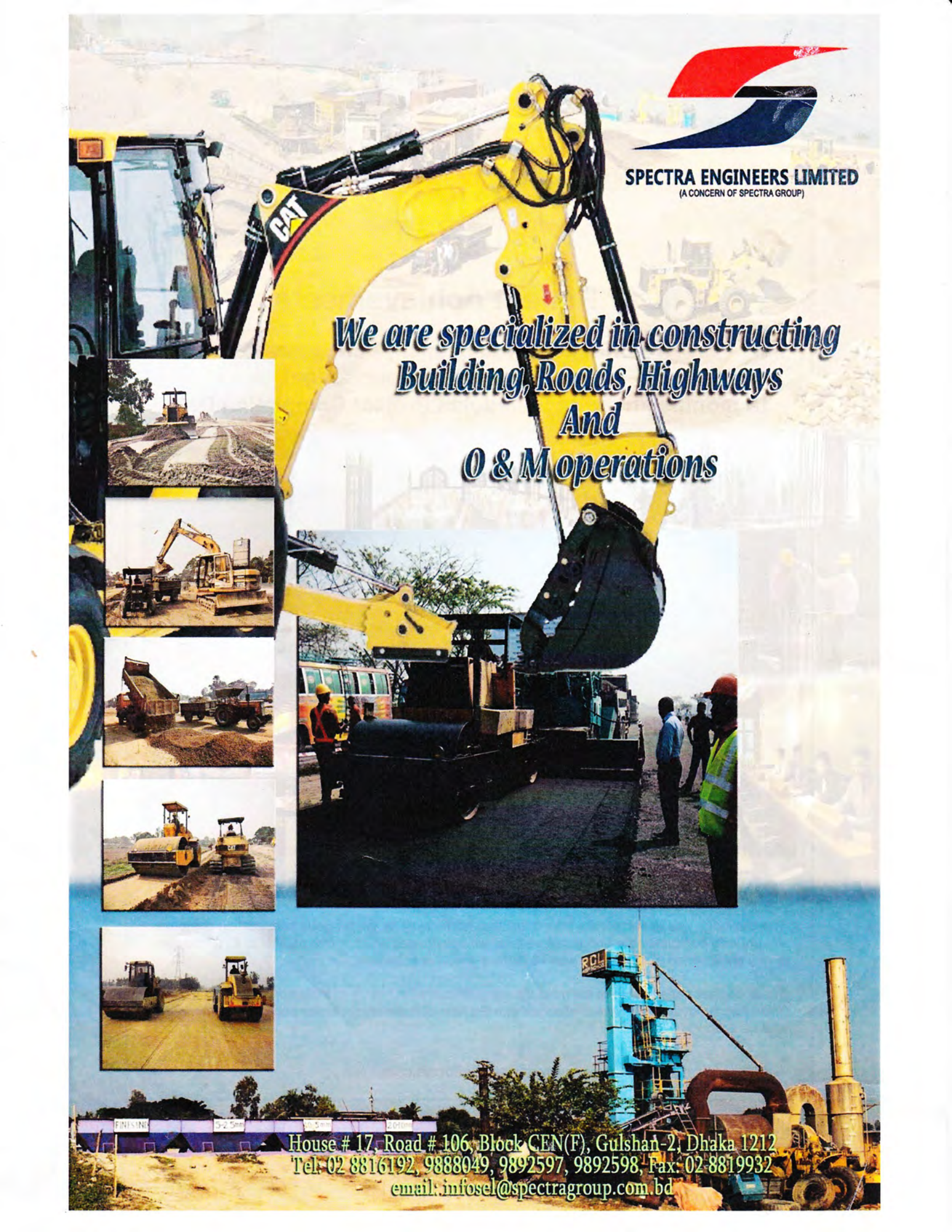
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