TSP Complex's Lucky Waste Product

by Jamiul Islam

The main deposit of Calcium Sulphate is found scattered widely on the surface of the earth at various geographical locations as on and known as natural gypsum. In a phosphoric acid fertilizer plant, gypsum is produced as a waste product and commonly known as phospho-gypsum. In Bangladesh there is no source of natural gypsum. Phosphogypsum is obtained in the production process by chemical action of sulphuric acid with rock phosphate in preparation of phosphoric acid required for manufacturing TSP fertilizer at Triple Super Phosphate Complex (TSPC), Chittagong — a lone enterprise of its kind in the country under Bangladesh Chemical Industries Corporation(BCIC). This Phospho-gypsum is pumped in slurry form to a twenty acres land earmarked as gypsum yard adjacent to factory site. The average production rate of phospho-gypsum is 1,00,000 MT per year.

Use of gypsum

In developing countries natural gypsum is used for manufacturing plaster of Paris, Plaster board, sulphuric acid and as cement retarder. Since phospho-gypsum contains acid like impurities, it requires purification before use under complicated industrial process. Normally gypsum is not used as fertilizer in other countries of the world. For utilization of this phospho-gypsum, several studies were carried out but due to high investment and unfavourable economics, there had been no development and progress for conversion of phospho-gypsum into marketable products till 1984 except its limited is used in two cement factories. About 11,000 MT per year could be used, the quantity of which is very negligible in respect to yearly production. As such with the passage of the time the holding capacity of the gypsum yard was being narrowed and the disposal of gypsum became a great headache to the local authority, who under this climactic situation of forced shut down of the factory decided to dump this already established waste product to the Bay of Bengal through pipes at a distance of five km.

To have favourable outcome through satisfactory commercial solution, the authority organised a large-scale exercise for use of this phospho-gypsum as fertilizer. At that time the factory came to know from a valuable publication based on Bangladesh Soil Survey by Bangladesh Agricultural Research Council(BARC) that there are about 4.5 million ha sulphur-deficient areas for balancing of which BADC launched an import programme of sulphur. With this hopeful information TSPC/BCIC requested BADC/IFDC to make a useful drive through private dealers to use gypsum having 18 per cent sulphur and 30 per cent calcium in sulphur-deficient areas instead of using imported sulphur. At the same time on IFDC expert working in Bangladesh also recommended gypsum for sulphur-deficient lands.

GYPSUM SALES QUANTITY

Year	Sale	Value/Ton(Taka) Ex-pond available moisture basis	Total Value(Taka)
1980-81	5,795	200	11,59,000
1981-82	13,641	200	27,28,200
1982-83	19,064	300	57,19,200
1983-84	24,768	300	74,30,400
1984-85	34,062	300	1,02,18,600
1985-86	40,881	330	1,34,90,730
1986-87	52,908	399.30	2,11,26,164
1987-88	56,920	399.30	2,27,28,156
1988-89	77,819	800	6,22,55,200
1989-90	89,995	800	7,19,96,000
1990-91	1,04,635	800	8,37,08,000
1991-92	1,23,823	800/1025	11,90,17,569

Out of total sale average consumption of cement factories is 11,000 MT/yr.

Accordingly, BADC through its private dealers started using gypsum as supplement to sulphur and succeeded in achieving positive result with the increase of crops production.

To establish phospho-gypsum as a right agent for correcting sulphur-deficiency of the land, TSPC later on held a seminar with BARC and took a long-term combined programme to make phospho-gypsum rapidly familiar at farmers' end. Since then TSPC started vigorous activities for marketing phospho-gypsum under planned programme like advertisement through different news media, leaf-lets, posters, calender and by sending representatives and arranging meeting with the help of BARC and local bodies at regular intervals to remote areas and achieved remarkable result by uplifting sale from 24,768 MT of 83-84 to 1,23,823 MT by 91-92. The waste product phospho-gypsum, disposal for which became a headache to the factory and corporation has now been possible to establish it as a life blood of the factory by ensuring continuous operation of the factory and turning the losing concern to a profit-earning unit.

Demand of Gypsum as fertilizer:

Sulphur has been established as a fourth primary plant nutrient and in Bangladesh sulphur is necessary for all kinds of crops. It is also proved that without correcting sulphur deficiency, desired productivity from land is not achieved even by applying other fertilizers. Sulphur not only increases quantity but also improves quality of produces adding more vitamin and protein value. BARC established that average yields increases from 20 kg/ha of sulphur (125 kg of gypsum) are 600 kg/ha of paddy, 360 kg/ha of wheat and 540 kg/ha of mustered seed. So, it is seen that the return against investment for gypsum is much more which attracts farmers greatly to use this gypsum.

Over five lakh metric tons of gypsum have been sold as fertilizer during the period of 1983 to 1992 and this saved import of over 80,000 MT of sulphur. The present cost of which is US $ 89 per MT plus 2% insurance.

As per BARC present requirement of gypsum to correct sulphur deficiency is over 3.5 lakh MT per year. Gypsum sale for agricultural use though has increased at an average growth rate of 30 per cent for last eight years, (as show in table) still there remains a large gap between use and estimated requirement. There are three source of sulphur in Bangladesh such as Amonium sulphate (S-24%), SSP(S-12%) and phospho-gypsum which is commonly and widely used.

In order to rapidly close the gap between the estimated requirement and sales, promotional activities have been expanded by improving lifting arrangement and adding mechanical loading facilities for trucks and rails with the provision of piling of gypsum outside the yard to allow drainage of free water and partial drying.

To cope with the population problem higher productivity of the land is to be achieved through proper utilization of gypsum and to reach the goal BCIC and BARC are working together under various active programme.

The Origin of Cosmic Rays

by Professor Arnold Wolfendale

It is an incredible fact that there is as much energy coming to the earth each second in the form of cosmic rays as there is in starlight. Yet while an enormous amount is known about the origin of starlight from an understanding of the many different types of stars in the universe, knowledge about the origin of cosmic rays is poor in the extreme.

THE years following the discovery of radioactivity by Henri Becquerel at the end of the last century, in his studies of uranium, saw the development of very sensitive radiation detectors. As instruments improved, they identified increasingly the subtle manifestations of the phenomenon of radioactive emissions.

Then as now, dramatic new discoveries were to follow the introduction of new instruments. Viktor Hess, the Austrian physicist, was one of the pioneers in the field of measuring radiation emissions. In the one of the experiments he carefully shielded his electroscope detector to exclude radiation. But there was still a 'leakage' or residual reading by the instrument, indicating that radiation was somehow still getting through the shielding.

Curiosity

Other researchers observed the curiosity. So in an effort to eliminate the effect of radiation from terrestrial sources, experiments with shielded electrometers were made aloft by balloon-borne instruments. The experimenters found a slight reduction, but of a smaller magnitude than expected.

Then in 1912 Viktor Hess, an ardent balloonist, decided to take a shielded instrument to as high an altitude as he could go in an attempt to eliminate ground-based influences.

The remarkable results obtained in the flight, which took him to 5200 metres, are shown in figure 1. Over the first kilometre Hess found the measurements by the instrument began to fall.

Then the readings, which show the ionisation current induced by radiation, started to rise again and displayed no signs of stabilising by the time he reached the highest altitude.

Imagine Hess's reactions to this result in his oxygen-starved state swinging in a wicker basket beneath a large hydrogen-filled balloon! They can be judged by his eventual analysis, based on averaging a number of 'sets of observations', when he concluded:

"The results of the present observations seem to be most readily explained by the assumption that a radiation of very high penetrating power enters our atmosphere from above, and still produces in the lowest layers a part of the ionisation observed in closed vessels."

Fertile research

Cosmic ray physics had started and with it a period, still continuing, of remarkably fertile research. Initially, cosmic rays were thought to comprise some sort of ultra-hard gamma radiation; which is why they were given their name. However, the name is a misnomer — they are mainly particles !

An illustration of the turmoil their discovery provoked is provided by the fact that it was 25 years before Hess's idea of an extra-terrestrial source for the radiation was accepted and he was awarded the Nobel Prize for his discovery.

The consensus now is that the 'Primary' cosmic rays, which impinge on the atmosphere from above, comprise mainly atomic nuclei, primarily protons but with a significant fraction of heavier nuclei, and a few per cent of electrons.

Strange particles

Also present are small fluxes of antimatter, in the form of antiprotons and positrons, and vast fluxes of neutrinos; particles of zero mass and charge, most of which go undetected. It is these primary cosmic rays which are of such interest for astronomy and it is their origin which has been such a puzzle for so long.

Most charged cosmic ray particles entering the atmosphere have velocities very close indeed to the velocity of light and they have a hectic time knocking into anything and everything in their path.

The details of what happens when cosmic rays strike other atomic nuclei are the stuff of fundamental physics — the nature of matter in its most elementary form.

Many of the 'really' elementary particles were discovered in cosmic rays, most notably the positron (antielectron), the muon, the pion and the so-called strange particles in the period up to the 1950s but more recently this area of science has come to be province of the big man-made accelerators.

Interest in cosmic rays has moved to the astrophysics of the problem — where do the particles come from and how do they travel through the universe?

Intensity drops

It also reveals that the rate of arrival of the low energy particles is quite high; for the secondary cosmic rays which arrive at ground level the total number of muons, mainly of low energy, penetrating our heads is about 5 per second. The intensity drops dramatically at higher energies, and it would at first sight seem remarkable that we are able to detect any at all at the highest energies.

The trick lies in using the vast cascades, or extensive showers of subsidiary particles, generated in the atmosphere by the very energetic primary cosmic rays.

Variety

For example, a particle of 10 electron volts causes a multitude of secondary interactions which give rise to about 100 million secondaries (mainly muons and electrons) at ground level.

A variety of factors cause the secondary particles to fan out on their downward passage through the atmosphere so that they arrive at the ground distributed over an area approaching one square kilometre.

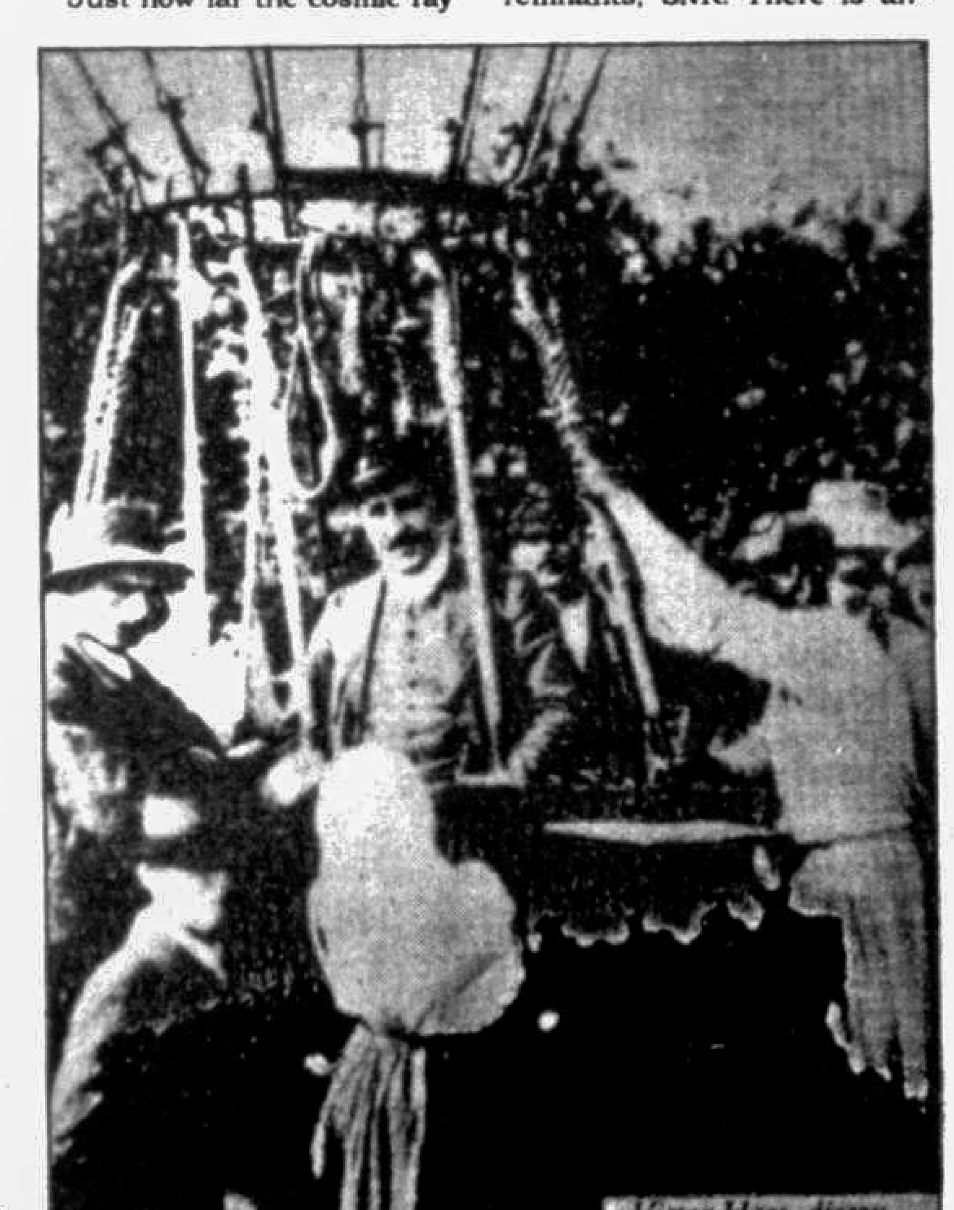
The consequence is that a limited number of detectors each of area one metre square or so will respond to such high energy primaries arriving at the top of the atmosphere over 1 km 2. Thus the day is saved and the very low rate can be measured.

The current maximum energy is about 1020 eV and Particles of such energy have been recorded at the UK Extensive Air Shower array operated by Leeds and Nottingham universities at Haverah park near Harrogate, and elsewhere.

Just how far the cosmic ray spectrum extends in energy is not known; We need a new technique which will extend the energy range accessible by several decades.

Why can we not just point a cosmic ray telescope at the heavens, determine the arrival directions and look back along the paths and identify likely exotic astronomical sources ?

The problem is that the Galaxy is threaded by a tangled magnetic field which deflects the charged cosmic ray particles hither and thither so that their arrival directions are very nearly completely random.



Victor Hess in his ballon gondola after the celebrated flight to 5200 metres from Aussig, in the former Austro-Hungarian empire, on 7th August 1912, that discovered cosmic radiation.

The other side of the coin is that the deflection of the very low mass electrons by the magnetic field causes radio waves to be emitted (the so-called synchrotron radiation) and this process is in fact responsible for the whole field of radio astronomy.

Loops of radiation

A fascinating feature is the presence of great loops of radiation coming out of the Galactic Plane and attributed to the remains of exploding stars, the so-called supernova remnants, SNR. There is another product of cosmic rays interacting with the entities in the interstellar medium besides the synchrotron radiation — the gamma rays — and we believe that these cosmic gamma rays are providing at least part of the answer to the origin problem.

It is poetic that cosmic gamma rays, first thought to comprise the cosmic rays, then written off, should make a comeback in this way.

It is true that they represent only a very tiny fraction of the cosmic radiation but their flux is finite, Gamma rays, unlike charged particles, travel in straight lines through magnetic fields, and one can thus trace them back to their sources.

The gamma ray sky has been studied so far with two gamma ray satellites and a third, the Compton Gamma Ray Observatory is in orbit at present.

The gamma ray sky shows a few discrete gamma-ray 'stars' (pulsars and some unidentified objects) and a general diffuse flux mainly concentrated towards the Galactic Plane.

Interactions

Our evidence for the sources of the cosmic ray protons — the majority component in the cosmic radiation — comes from this diffuse flux, much of which we believe to come from the interactions of cosmic ray protons with the gas in the interstellar medium.

Until recently there was argument as to whether the cosmic ray protons seen were coming mainly from sources within our own Galaxy or were coming from outside; ie.were 'extragalactic'.

Analysis of the diffuse gamma rays seems to have sorted this problem out, for protons with energies below 1010 eV or so at least.

The method is to work out on a large scale the distribution of cosmic ray proton intensity in the Galaxy-assuming a simple dependence on distance to the centre of the Galaxy — which would give the observed distribution of gamma ray flux.

Likely Galactic sources?

Pulsars seem unlikely at these energies; though perhaps their contribution is important at much higher energies?

Instead, we have evidence for the supernova remnants (SNR) referred to earlier. There is evidence for the SNR loop which shows up so well in the radio maps having a higher cosmic ray intensity within it than outside it, and some similar evidence for other old SNR.

Interestingly enough, models for cosmic ray acceleration in SNR give predictions quite close to what we appear to find and the result is that SNR are probably the prime candidates for 'cosmic ray accelerators' at 'low' energies this being where most cosmic rays are to be found.

The SNR mechanism probably works up to about 10 14 eV above which, according to the modelers, SNR become inefficient. At higher energies pulsars may be important sources but again there is an energy (10 17) beyond which their efficiency is in doubt.

At even higher energies, specifically, above 10 19 eV the plot thickens still further insofar as most workers have considered that Galactic sources are most unlikely and that we should look further afield. This is where we have recently started to make some rather dramatic discoveries (assuming, that is, that they are right).

Together with colleagues from Poland, India and China, I have spent the last year looking at the world's data on particles of energy above 10 19 eV, some 800 particles in all.

By examining the characteristics of the showers generated by the particles we find two main results; there seem to be a lot of heavy nuclei (probably iron) present and there is a small enhancement of intensity in the direction of the Galactic Plane but away from the Galactic Centre.

Intriguingly, there seems to be an excess of protons amongst these 'Galactic Plane' particles.

Higher intensity

Now in the direction away from the Galactic Centre the local spiral arm is close enough for any sources to show up and this is why we think we are seeing evidence for a higher intensity than elsewhere. Towards the inner Galaxy we see no excess but this is understandable in view of the spiral arm in that direction being too far away.

Chancing our arm, we have pinpointed actual hot-spots may correspond to the actual direction of the sources but their veracity is not guaranteed. Nevertheless, we note that our best hot sport is towards an interesting pulsar, fascinating in that it is nearby and has the strongest surface magnetic field of any pulsar known.

We are not claiming that all cosmic rays of the highest energy come from Galactic sources— there is strong evidence that some come from outside the Galaxy-presumably from other much more energetic galaxies.

Nevertheless many cosmic rays do come from the Galaxy; not only the protons from nearby sources but all the iron nuclei which we think we have identified.

Left over from the big bang

The point here is that iron nuclei cannot have come from very distant galaxies without breaking up on account of collisions with the 'cosmic microwave background' — the radiation left over from the big bang.

To have shown that there are cosmic ray sources in our galaxy capable of accelerating particles to the highest energies known to mankind (1020 eV) really puts the cat amongst the pegeons insofar as the theorists are concerned.

I mentioned earlier that the models even for pulsars give out at 10 17 eV —a factor one thousand short— so that some very clever footwork will be required. Meanwhile, we soldier on, poring over the data.

— *Spectrum.*

Tricking Locusts into Staying Single

A team of scientists in Kenya is trying to fight the global threat from locusts by identifying and then tampering with the causes of various stages of locust behaviour.

At the heart of the research is one of the major mysteries of locust life: what causes the essentially harmless solitary locust to combine with millions of others in voracious swarms that can cover more than 1,000 square kilometres (386 square miles), flying over 300 kilometres (186 miles) a day?

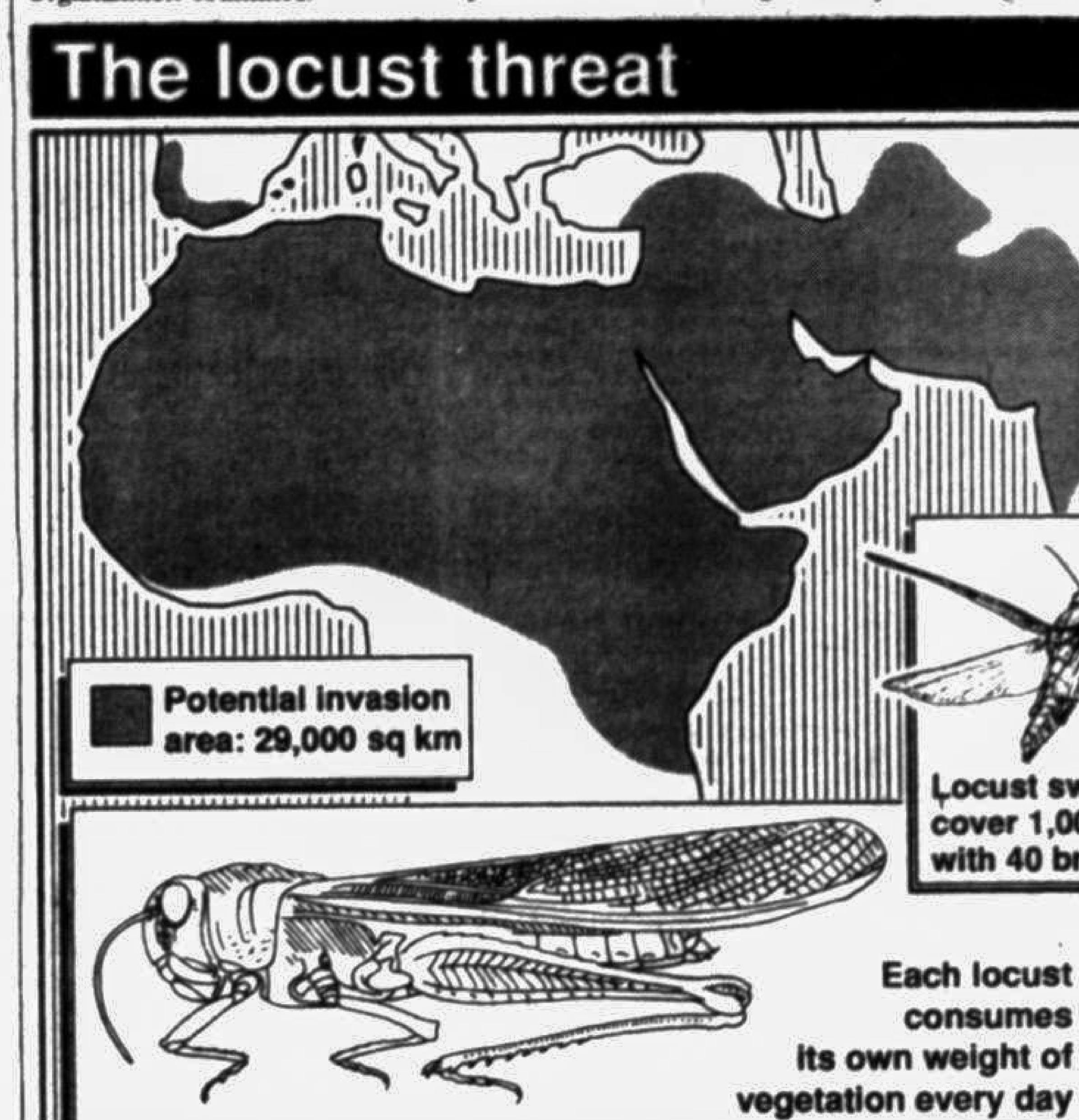
Each locust consumes its own weight of vegetation every day. The last major infestation, in 1988, cost countries in northern Africa US$1 billion in agricultural losses, according to UN Food and Agriculture Organization estimates.

Says Professor Thomas Odhiambo, director of the Nairobi-based International Centre of Insect Physiology and Ecology (ICIPE): "The aim is to keep the locusts firmly on the ground."

International attempts to find new ways of controlling locusts stem from concerns about the environmental and human damage caused by the highly toxic pesticides, such as Dieldrin and malathion, currently in use.

Chemicals, says Prof El Sayed El Bashir, who heads the Institute's locust research programme, are becoming "expensive and hopeless."

ICIPE scientists are working on the hypothesis that locust behaviour is controlled by natural chemicals in their bodies, which could be isolated, synthesised and used against them.



So a major effort is underway to de-code the insect's chemical language, particularly the signals that trigger the formation of swarms, synchronised and accelerated sexual maturity, and communal egg-laying.

Since solitary locusts are more selective then swarms in the choice of plants they eat, particular plants may contain locust-attracting chemicals.

Similarly, locusts manage to find their mates, even though they may be up to 10 metres (11 yards) apart, suggesting the existence of pheromones (substances secreted by an animal for detection and response by another of the same species). A warm multiplies 30-fold every time breeding occurs, which in ideal conditions can be three or four times a year.

Bashir says it is also possible that certain colours, even perhaps the reflection of the desert sand, are a factor in determining whether a locust stays solitary or becomes gregarious.

"Some aspects of this research have been studied before," he says, "but the tools were rudimentary and funding was limited."

Finance for ICIPE's research is provided by a range of bilateral and international organisations, and has paid for a locust-rearing facility at its Duduville ("Insect town") headquarters a few kilometres from Nairobi.

The seven senior scientists and six scientific staff have also been watching locusts in the insect's natural habitat on Sudan's Red Sea coast.

In addition they are investigating the possibility of biological control of the pests, which periodically affect more than 50 countries covering one-fifty of the Earth's land surface.

Bashir explains that current insecticide-based approaches aim to kill entire swarms, but the strategy under consideration would involve the release of pathogens (agents of disease), which would be transmitted from one generation to the next. In every species, there are some members who survive disease, and the idea is that the survivors would pass the pathogens to their offspring.

The problem is that few pathogens survive the harsh conditions in areas of locust infestation. But for the main pathogen under scrutiny at ICIPE, a 50 per cent mortality rate has been observed 18-20 days after infection, eventually reaching 80-85 per cent.

Bashir stresses that many other scientists are working on locust control programmes "It is a regional pest which knows no boundaries."/PANOS

Science Brief

Cheaper, Cleaner Iron-Making Technology from Austria

AN Austrian metallurgical company has developed a new process technology for the production of liquid pig iron from iron-ore that has several advantages over the conventional blast furnace route of iron manufacture.

The new COREX technology developed by Voest Alpine industrieanlagen bay in Austria is based on a revised sequence of metallurgical processes that will reduce iron production costs by upto 50 per cent and eliminate the need for using expensive coking coal.

The new process technology has been successfully demonstrated at plants in Germany and South Africa, and Voest Alpine is now looking for buyers of the new technology in other countries including India.

The COREX process uses the metallurgical processes carried out in a coking plant and a blast furnace in a different sequence to avoid the necessity of using coking coal, but produces the same quality of hot metal.

Voest Alpine says the COREX process will be specially attractive to India because it avoids the use of coking coal in iron making. India had to import 4.5 million tonnes of coking coal last year worth Rs 500 million for use in blast furnaces.

The process steps are carried out in two reactors — the reduction furnace, in which iron ore is prereduced, and the melter gassifier that has high-value reducing gas and is used to melt the prereduced iron ore.

The noncokign coal is charged into ultrahigh temperature melter gassifier and gassified into a high value reducing gas mainly made up of carbon monoxide and hydrogen. The hot reducing gas is brought to reducing temperature of about 850 degrees Celsius and introduced into the reduction furnace in counterflow to iron ore descending down the furnace under the influence of gravity. The iron ore is thus preheated and prereduced to a high degree of metallisation.

The hot and metalized material is extracted from the reduction furnace by screw conveyors and drops into the melter gassifier underneath. It is here exposed again to a high temperature reducing atmosphere and finally reduced and malted by residual char in the lower part of the gassifier. The export gas resulting from the reduction can be used as fuel either for the generation of electric power, or for heating in metallurgical furnaces.

Voest Alpine officials say production costs via the COREX process will be about 30 to 40 per cent less than the blast furnace route for the production of pig iron.

Cyanide, sulfide, and ammonium aqueous emissions in the COREX route are about 10 times lower than in the conventional blast furnace process. Phenol emissions are also lower. Gaseous emissions of oxides of nitrogen and sulphur dioxide are also nearly 60 times lower in COREX.