

High Temperature Fuel Cell Systems Kindle Hopes

By T. V. Padma

SCIENTISTS are pinning hopes on the newly emerging high temperature fuel cell systems to solve some of India's pressing problems in power generation. Fuel cells, essentially energy conversion devices that convert the chemical energy of a reaction between a fuel and an oxidant like air directly into electrical energy, generate more power efficiently and with less pollution, according to a report by scientists at the Central Electrochemical Research Institute, Karaikudi, in the Journal of Scientific and Industrial Research.

With the gap between the power requirements of and power generation in the country widening every year and the efficiency of thermal power plants stagnating at 45 per cent, high temperature fuel cell systems are kindling hopes of delivering power at higher efficiencies of 45 to 55 per cent and low capital cost. The country, at present, depends on thermal power plants to supply nearly 60 per cent of its total power.

The fuel cell efficiency is independent of its size, and is not controlled by some of the operational limitations of thermal power plants.

Fuel cells are classified according to the electrolytes used and temperature of their operation. Low temperature fuel cells working below 150 degrees Celsius employ aqueous electrolytes; medium temperature fuel cells operate at 200 to 250 degrees Celsius using phosphoric acid as electrolyte; while high temperature fuel cells generate power at 650 degrees to 1000 degree Celsius employing molten carbonates or solid oxide electrolytes.

The advantages of high temperature fuel cells over other types include high efficiency (50 per cent), low cost and the ability to use gaseous fuels derived from coal.

Because of the high temperature of operation, high current and power densities are obtained without much loss of polarisation voltage. Also no special noble metal catalysts are required.

These systems are well-suited for cogeneration of electric power and high-grade heat, thus offering efficient utilisation of available fuel energy.

Further, carbonaceous fuels derived through coal gasification or reformed natural gas can be employed, and the overall thermal efficiency of the system can be enhanced to 60 per cent by recycling the high-grade waste heat recovered from these systems to produce additional power.

Scientists at the Bharat Heavy Electricals Limited (BHEL), Hyderabad, have already developed India's first working model of fuel cell power pack that produces electricity from a mixture of air and hydrogen.

BHEL's model, the size of a briefcase, contains a stack of electrochemical cells connected in series to a source of hydrogen, while oxygen is available in air. In places where hydrogen is not readily available, BHEL's system can use methanol instead.

BHEL's fuel cells are essentially the phosphoric acid type (PAFC) using phosphoric acid as an electrolyte and platinumised carbon as an anode, the platinum acting as a catalyst. Steam produced as a byproduct can be used for heating

purposes.

According to the Karaikudi researchers, India has abundant potential to generate biogas which can be used as a fuel in stand-alone fuel cell power plants. India can generate about 200 million tonnes of agricultural wastes which can be either fermented to produce biogas or gasified to yield producer gas.

Since it is relatively cheaper to process natural gas than coal, the development of natural gas-based fuel cell plants should be taken up as a first phase and coal based plants as a second phase.

Natural gas based systems are solid oxide fuel cell (SOFC) systems. They reduce the capital cost and the waste recovered in an SOFC at 1000 degrees Celsius may be used in coal gasification also.

The molten carbonates fuel cell (MCFC) technology uses porous nickel electrodes and an electrolyte tile which contains the molten carbonate electrolyte necessary for ionic transport.

The MCFC is a quiet and clean power generation device. When operating at 650 degrees Celsius, it has higher cell efficiency, that is 55 per cent, compared to 47 per cent of present versions of PAFCs that operate at 210 degrees Celsius.

A 2-10 MW MCFC operating on natural gas has an overall efficiency of about 50 per cent, which can reach up to 55.6 per cent with internal reforming capabilities, compared to even the best optimised PAFC system which has 40 per cent efficiency at comparable heat rates.

Studies carried out by the Gas Research Institute in 1979 have shown that air pollutants are reduced by a factor of more

than 10 for fuel cell systems compared to conventional systems such as coal, or natural gas-fueled power stations and on-site boilers.

There are other advantages: no precious metal catalysts are required; reactant gas cooling is readily accomplished; reject heat is at a higher temperature and there is potential for very low rate.

Its disadvantages include corrosion of components, extended starting time, and intolerance to sulphur.

For utility applications using coal-derived fuels, the MCFCs are preferable to PAFCs. The higher temperature of an MCFC permits production of more electricity from its high grade waste heat.

MCFC technology has received special attention in Japan and the European Economic Community (EEC) countries, and though it is lagging by five to seven years behind PAFC, it is expected to receive advance technology status once the disadvantages are tackled.

The solid oxide fuel cells (SOFC) with yttria stabilised zirconia electrolyte operate at around 1027 degrees Celsius and utilise ceramic materials almost exclusively. Nickel serves as the anode electrocatalyst and strontium doped lanthanum manganite is the cathode electrocatalyst.

Owing to high temperature operations, the overall efficiency of the SOFC is higher than that of MCFC. Use of high-grade waste heat from the fuel cell to gasify coal is also possible.

An additional attraction of an SOFC system is its anticipated high reliability and long life which are so characteristic of solid state devices. Also,

there are no corrosion problems, no electrolyte management and better tolerance to sulphur contaminants in the fuel than the MCFC.

Fuel cell technology has many potential applications in India. Electrification in villages is a major outlet for stand-alone fuel cell power plants.

Since fuel cells deliver direct current (d.c.) power, they can be directly coupled with electrochemical industries that use large sums of d.c. power, such as aluminium industry, chloralkali and electrolytic copper refining.

Fuel cells' d.c. power output can be utilised directly, eliminating the need for rectifiers and the hydrogen produced as a byproduct can be used to generate the industry's additional d.c. power requirements.

Dispersed MCFC generators coupled with natural gas fuel system, particularly with internal reforming capability can compete with conventional power generating systems in these applications, at about one-fifth the cost.

In India, the Department of Non-Conventional Energy Sources (DNES) is promoting indigenous fuel cell research. DNES has sponsored various projects on PAFC system so far, with BHEL, CECRI, Central Glass and Ceramics Research Institute (CGCRI), Calcutta, and Tata Energy Research Institute (TERI), New Delhi, as participating agencies.

DNES has identified CECRI, Karaikudi, as the nodal agency of its MCFC programme and CGCRI, Calcutta, for SOFC programme.

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What do We Get from Space Monitoring?

USE of space technology for Earth studies is a promising means of assessing the state of the biosphere and its ability to resist man's impact.

The Soviet means of Earth study — orbital Mir system, Cosmos, Resurs-O1 satellites etc. — supply data of tremendous scientific and applied value.

The methods of digital interactive information processing, developed by Soviet specialists from the Moscow-based Research Center for Space Ecology, are handling crucial problems in environmental management.

The Soviet Union today has operational computer complexes with good software backup. With the use of special methods they can keep an eye on large and small cities, water bodies and forest ecosystems," director Julian Novikov says.

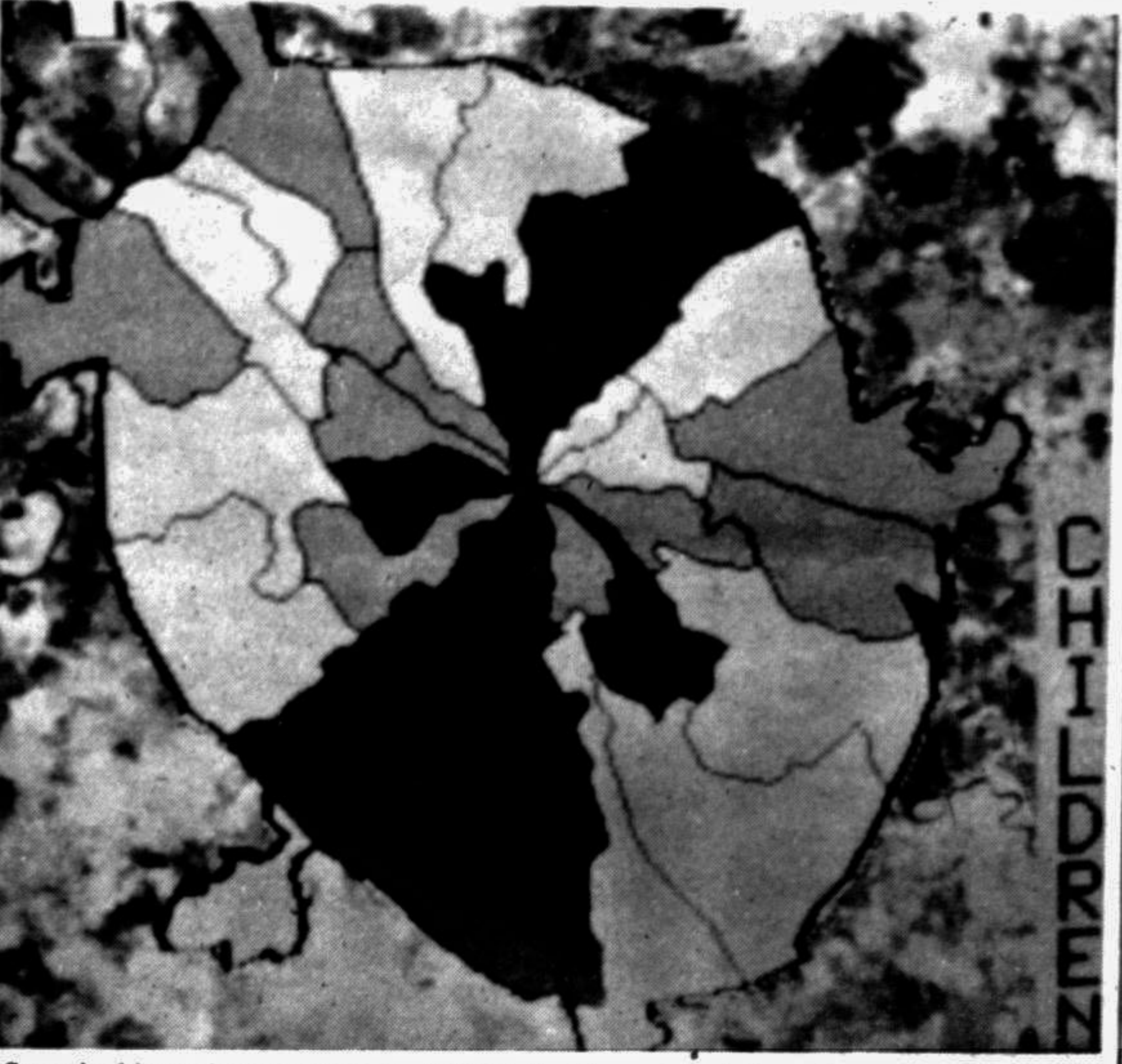
"Use of space information for assessing the state of the environment makes it possible to single out fixed anthropogenic zones in cities, districts and suburban areas, and monitor even minor pollution sources.

This brings near environment-quality control and makes it possible to discover the spread of negative impact in a region, area, city, districts and junctions. With the experience it has, our center is prepared to sign contracts with foreign countries on processing space information and singling out their environmental problems."

Recently, Soviet scientists studied the environment in the two largest Soviet cities — Moscow and Leningrad — and made an epidemiological analysis of bronchitis, pneumonia, bronchial asthma, respiratory allergies, flu and respiratory diseases, and acute chronic tonsillitis.

They established the correlation between the ecology and disease incidence.

This discovered what caused different diseases and their connection with the habitat and workplace ecology. Space monitoring in combination with medical information will help find regions with above-usual disease incidence, forecast such processes, focus their efforts on disease prevention in the trouble zones, and take timely steps towards a better environment. Ecological-epidemiological space monitoring in pulmonology, oncology and other areas in medicine is becoming a possibility. — Y.Z.



Spread of lung diseases among children in Moscow, as follows from space-monitoring results. In the light areas, disease incidence is at the average city level, in the grey areas 10%, and in dark areas 20% above average.

Landuse Objective and Remote Sensing

by Ahmed Hossain Shah

THE development of an under privileged economy like ours is largely dependent on the transformation of the traditional agriculture into a modern one. It depends on breaking the established equilibrium. A change in the technology involving the introduction of modern inputs specially human and materials, capital can provide the break-through. This truth has inspired our policy to widen the scope of scientific education to encompass the masses. It's objective is to help those with scientific aptitude use properly their own potentials in the field of agricultural development where they can make a mark of their own. At the same time some practical steps have been reportedly taken to formulate and develop scientific infrastructure aimed at accelerating the face of development conforming to our needs. With this light, for the sake of development, studies and research works are being done vigorously. No doubt, some nations have been providing us with some assistance and help for development of our agriculture. With this view, the UNDP has approved a project for continued assistance in the field of applied remote sensing technology for agricultural development in our country.

Industrial crops, livestock, fish and forest production so as to support all the country's population at a satisfactory standard of living. The salient features of land use development programme lies in the remote sensing activities with land mark survey as modern agricultural science says.

By the project of remote sensing UNDP is assisting our SPARRSO (Space Research and Remote Sensing Organization) in strengthening its scientific and technological capability for the betterment of agriculture.

It will also be receiving assistance in expanding its linkage with foreign institutions involved in remote sensing activities in cooperation with the ESCAP region. So far, this project has been executed by the FAO on behalf of UNDP. In near past, the importance of the remote sensing project for agricultural development can hardly be over emphasized.

However, urgently needed now, is transfer of personnel skill from the developed countries through those receiving training in the subject so that we may be able to utilize and also develop further our remote sensing technology independently in future.

It is to be noted here that

dependence on foreign experts can never help us develop our science and technology to meet our own needs and demands. The UNDP financed project should also emphasize the importance of this aspect for the sake of agricultural development so that its ideal of strengthening SPARRSO in its scientific and technological capability can be translated into reality in the real sense for agricultural productivities increase.

In Bangladesh, there is a great potential for increasing foodgrain production through agricultural development activities by the adaptation of remote sensing techniques and procedures for atleast 3 times from its present activities by the end of five year plan (which will perhaps be ended in 1990).

The people and their research scientists with modern technology like remote sensing are, of late, working constantly to correct the flows and to make agriculture and even better for public good.

Beyond this point, however, there were some differences of opinion regarding its application threatened at times to develop our own agriculture by the application of latest meth-

ods.

Bangladesh is still mainly a rural country and is vigorously trying to develop its rural areas. So its development of rural and associated research can be relevant to its agricultural development through resource utilization of remote sensing technique application Bangladesh seems also a market for its cash crops for western agricultural goods and services to aid its development and fill temporary deficits.

Information on Bangladesh agriculture through remote sensing methods seem relevant to experts in rural development and to agricultural scientists. It is also relevant to those who need to know where agricultural cooperation can begin, those who want to share their experience with the developmental approach and those who offer agricultural products.

Contrary to the view held by many, the SPARRSO in Bangladesh has been based on a carefully designed system of incentive which reward efficiency even at the cost of permitting some degree of inequality. Although increasing efforts are needed in agricultural research and remote sensing techniques, it should be possible to increase foodgrain production faster than the population growth.

It may be concluded here that the adoption of remote sensing technique will thus give us a tremendous developmental result in agriculture with its modern application methodology.

THE chances of patients with damaged knee joints being wrongly referred for surgery may be fewer, with the development of a new technique by doctors in Belfast which greatly increases the accuracy of diagnosis.

The human knee joint is well equipped to accommodate the large stresses that it often experiences, especially due to the physical exertions of sportspeople. Interspersed between the femoral condyles and the tibial plateau are two crescent-shaped fibro-cartilage structures known as menisci which act as shock absorbers for the joint.

Occasionally, however, one or other meniscus may be injured as a consequence of an unnatural movement of the joint under load, resulting in a partial or complete tear of the structure.

In most cases, this causes pain that is often accompanied by a clicking sensation in the knee and, in the most extreme cases, the partially detached piece of tissue can interfere with the normal movement of the joint and cause it to lock, preventing the person from straightening or bending the knee.

Fortunately there is a straightforward surgical remedy for this condition, thanks to the technique of arthroscopy. This involves the insertion of a light guide into the knee to permit viewing of the joint surfaces, and the insertion of tiny surgical tools to enable excision of the torn portion by the orthopaedic surgeon. It has revolutionised the treatment of meniscal injuries.

However, the technique is costly and it is important to exclude from the selection patients all those who are experiencing knee pain as a result of some condition that cannot be treated by arthroscopy. This discrimination is often difficult to achieve.

Clinical tests described in the past to help orthopaedic examiners make their diagnoses have shown that even the most experienced examiners could not expect to achieve any better than 70 per cent diagnostic accuracy. Clearly there is still room for improvement which is why a research programme was undertaken at the Department of Orthopaedic Surgery, Musgrave Park Hospital, in Belfast, North Ireland.

Most of the clinical tests that have been described involve three particular types of skill on the part of the examiner. Typically he is required to manipulate the joint in some manner to simulate the conditions in which the patient normally experiences pain. Then he must detect each and every sound and vibration that is produced in the knee joint by

Sound Diagnosis of Torn Cartilages

manipulation. Ultimately, to reach a diagnosis, he is expected to distinguish expertly between the different types of sound or vibration detected and to recognise those which are characteristic of a particular pathology.

It is a tribute to orthopaedic practitioners that they are able to achieve 70 per cent diagnostic accuracy given such stringent demands upon their skill.

However, modern technology has now provided tools that can greatly reduce the required level of skill for these tasks and thereby increase the expected accuracy of diagnosis.

The BBN 501 accelerometer manufactured by Vibrometer of Hazel Grove, northwest England, weighs about 2 g and can be adhered easily to the surface of a vibrating body without adding significantly to its mass. It contains an internal pre-amplifier that converts the acceleration values of the vibrating surface into an electrical signal that can be processed by conventional methods. Doctors showed in 1980 the superiority of accelerometers over microphones (which were favoured at that time) in detecting joint vibrations. This is the basis for the technique known as vibration arthrography, which involves recording and analysing the vibration from human joints.

By adhering three accelerometers around the joint, any vibration will be detected by at least one of the sensors. This relieves the examiner of the skill of detecting such vibrations. The electrical signals may be stored by a computer on floppy disk for retrieval.

The facility of studying the signals after the examination and of comparing their characteristics against a bank of stored signals makes discrimination between pathological and normal ones a relatively simple task.

Furthermore, it may be assumed that an event occurring within the joint will cause a vibration that will be sensed simultaneously on all three sensors, and signals that occur on only one sensor channel may be excluded from consideration.

More detailed frequency analysis of the vibrational signals may now make it possible that automatic discrimination will soon be implemented in the software of the knee screener.

The final hurdle to the diagnosis of meniscal injuries is manipulation of the joint to produce significant vibrations.

The two major components in the manipulation are compression of the joint by longitudinal force between the foot and the thigh, and rotation of the tibia. These have been implemented in the design of an exercise machine on which a patient can manipulate his own joints during a strictly controlled exercise routine.

A preliminary trial of this apparatus was carried out on a small sample of 30 patients who were scheduled for arthroscopy.

In addition to the vibration sensors, an electrogoniometer for measuring the knee angle was attached to the leg. The signals were recorded by the computer and analysed by the examiner.

Tentative diagnoses were attempted at this stage, based observations that the angle of the joint at which a signal occurs indicates the position of the tear in the meniscus, and the side of the knee that has been injured will typically give rise to a stronger signal from the sensor. These diagnoses were then compared against standard arthroscopic diagnosis.

At this stage the treatment of the patients was not in any way influenced by the finding of the knee screener. The result was an overall diagnostic accuracy of 86 per cent, and a sensitivity of 96 per cent for meniscal tears.

Larger studies have now started and the commercial future of the Belfast knee screener as a tool for reliable diagnosis of meniscal injury will be determined by the results. It is expected, however, the diagnostic accuracy may be improved significantly by the technique of vibration arthrography.

The clinical and financial benefits of this will be significant as fewer people will be erroneously referred for surgery, achieving a much needed reduction in hospital waiting lists.

PIPELINE COATING WILL KEEP OIL FLOWING

Tests in Britain are expected to lead to a new coating that can maintain the temperature of hot oil being transported through pipelines and at the same time protect them against corrosion, according to a London Press Service report.

The uninterrupted transportation of hot oil along sub-sea pipelines from the well to a processing plant is one of a number of technical problems facing engineers as they seek to make economic sense of exploiting smaller than normal reserves of oil in place such as the North Sea.

Oil is hot when it emerges from a well but the need to pump it several kilometres by pipeline means that it can start to cool en route and cause wax or hydrate formation. Scientists believe the answer is to apply a special coating that can give the pipeline sufficient thermal insulation to maintain the temperature of the oil flowing through it. An added bonus would be in-

creased protection against pipeline corrosion. The civil engineering department at Heriot-Watt University in Edinburgh, Scotland, has now joined forces with the Capcis company of the University of Manchester Institute of Science and Technology to identify and test material suitable for use as an insulation coating.

The project brings together the expertise of the Capcis company in materials selection and corrosion prevention, and the specialised test facilities at Heriot-Watt that can simulate the demanding conditions which a sub-sea pipeline coating would have to survive in use in the North Sea.

Senior lecturer in civil engineering at Heriot-Watt, Dr David Haldane, says the project will assess in laboratories the capabilities of materials currently available and suitable for use as insulation coating systems, prior to full-scale testing of selected systems applied to 12-metre pipe lengths to sim-

ulate the effects of installation conditions.

The coated pipes will then be tested with hot oil inside and sea water outside under hydrostatic pressures as would be the case on the seabed. A special test cell will be built at Heriot-Watt to do this and to measure the thermal insulation and other properties under real life condition, he said.

The research is being sponsored by seven oil companies as well as the offshore safety division of the UK Health and Safety Executive.

PULSED AIR DRYING TUNNEL

A French company, Tiflex, has developed a pulsed air tunnel for the accelerated drying of solvent printing inks on paper, cardboard, self-adhesive labels, sheet plastics and wood and metal panels, reports French Technology Survey.

The drying process involves blowing jets of hot air over the

printed surfaces. The air is heated by being passed over shielded resistors. A high power fan in each unit circulates the air at high speed and presses the thinnest sheets down on the conveyor belt.

A suction bench is arranged between the hot and cold units to draw off the hot air for recycling, giving appreciable energy savings. The system is designed in 2-metre sections so that a highly evaluative system can be matched exactly to the user's needs.

The main features are a conveyor belt in tough, stable polyester on standard models; a teflon/glass conveyor belt for mixed tunnels consisting of one standard section and one infrared or ultraviolet section; adjustment of the parallelism and tension of the belt and temperature control by thermostat.

With its robust construction, carefully designed thermal insulation and silent operation, this pulsed air drying tunnel is a particularly homogeneous and efficient system which satisfies the current concern for energy savings and for healthy conditions at workstations using solvent inks.

— PTI.

NEW CTC MACHINE SPEEDS UP TEA PROCESSING

The Sennova tea processor, as the machine is called, has been under commercial operation since 1987 and results obtained from its use confirm a major breakthrough in tea processing technology, says Mr Sen, a tea planter, engineer and tea taster in a report in "Invention Intelligence."

The machine is also being imported to Turkey, Bangladesh and Kenya, while Sri Lanka and Indonesia are showing interest in the equipment.

The major parameter for tea making is specifications of the processing surface which were first laid down way back in 1935 by Sir William Mckercher.

While designing the machine, its inventor attempted to eliminate the need for pre-