Inside a nuclear reactor

QUAMRUL HAIDER

ALTHOUGH many words have been written in the past to justify nuclear power as the magic bullet that would replace fossil fuels, USA and rest of the industrialised nations realised after the 2011 Fukushima accident that nuclear technology has failed to offer a safe way of generating clean power. Yet, a politically unstable country like Bangladesh is going ahead with the potentially risky venture of building a nuclear power plant at Rooppur. Moreover, it is not clear whether the government has the necessary infrastructure (transportation, security, township for staff, availability of cooling water, nuclear waste repository, etc.) and a strong cadre of nuclear engineers in place for the safe operation of a nuclear power plant. There is also lack of information about the safety aspects related to the local topography, geology, and seismology.

In the absence of transparency, a good way of judging whether nuclear option is right for Bangladesh is to understand how a power reactor works. One can then weigh the risks against the benefits of nuclear energy.

A nuclear reactor generates energy by controlled fission reaction. A typical pressurised light-water reactor that will be built at Rooppur consists of four essential components: Fuel to provide energy; a moderator to slow down the neutrons to make it more likely that they will cause fission; coolant to transfer thermal energy away from the fuel; and neutron-absorbing control rods that can be moved in or out to slow down, speed up, or stop nuclear fission.

Because of its abundance in nature, most nuclear reactors use uranium as fuel. Natural uranium contains 0.7% of the fissile uranium-235; the rest is non-fissile uranium-238. When uranium-235 is bombarded with a slow neutron, it captures the neutron to form uranium-236, which undergoes fission producing two lighter fragments and releases energy together with two or three neutrons. These neutrons in turn cause more fission resulting in a self-sustaining chain reaction.

The fuel is loaded into long, thin rods which are submerged into a pool of water. The core of the reactor, housed inside a pressurised containment vessel, contains the fuel rods. Nuclear fission occurs in the rods generating heat in the core. To prevent leakage of the radioactive fission products, the rods are encased in a solid cladding made of an alloy of zirconium.

The core is maintained at a sufficiently high pressure so that water remains liquid even at very high temperatures. The super-hot water is pumped to a heat exchanger to produce steam. The steam drives the turbine, which spins a generator that produces electrical energy.

When the fuel is depleted, the rods are removed and replaced by new ones. Disposal of the spent fuel rods contaminated with highly radioactive material is a major headache for the industry.

The neutrons produced during each fission event move very fast and will pass right through the uranium-235 nuclei without causing them to fission. They must be slowed down to be captured by uranium-235 and induce more fission. To slow down the neutrons, a moderator material is used. The most efficient moderators are light materials such as water. Neutrons slow down when they collide with the hydrogen (proton) in water.

Although protons are very good moderators, they also efficiently capture neutrons to form deuterons. Reactors using water for the moderator compensate for neutron capture by using fuel enriched to about 3% uranium-235. Enrichment is a very dangerous and expensive process, requiring sophisticated technology.

Most power reactors use water as both moderator and primary coolant. The coolant circulates throughout the core to prevent it from overheating and melting down due to the heat generated by the fission process.

Nuclear plants have to routinely remove from the reactor heated water contaminated with radioactive material. The water is filtered and then some of it is either recycled back into the core or released as vapour into the environment through the cooling towers. The rest is usually discharged into the reservoir from where water was drawn to keep the reactor cool. Improper discharge of water will adversely impact the entire ecosystem of the region.

If all the neutrons from each fission event are allowed to produce additional fission, the chain reaction will grow exponentially and result in a nuclear meltdown in a very short time. A reactor is considered safe when a self-sustained chain reaction is maintained with exactly one neutron from each fission inducing yet another fission reaction. This is achieved by using control rods. These are rods made of cadmium or boron which absorbs neutron without fissioning. They are raised if there aren't enough neutrons to sustain a chain reaction and are lowered when there is an excess build-up of neutrons. If at any time during operation there is a runaway chain reaction, the control rods will fall into the core automatically, absorb all the neutrons, and shut down the reactor.

A major cause of concern is that, even though the control rods will almost certainly stop the chain reaction in the event of an accident, the reactor will still be extremely hot because the uranium atoms that have already fissioned produce radioactive by-products that themselves give off a great deal of heat. Thus, the reactor core will continue to produce heat in the absence of fission causing the core's temperature to rise. It will eventually result in a meltdown, unless the emergency core-cooling system starts operating immediately.

However, it is by no means certain that the safety systems are one hundred percent foolproof and will work as designed. The Fukushima disaster has shattered the "zero risk" myth of power reactors.

Finally, the Russian VVER-1000 model reactors that will be built at Rooppur are a bit like the DC-10 aircrafts that Bangladesh Biman still flies. Both are technological artifacts of yesteryear.

The writer is a Professor of Physics at Fordham University, New York.

NOT WARLIKE

War arose recently!

Study of hunter-gatherers finds few lethal raids on opposing groups

A battle has broken out among scientists trying to untangle the origins of war.

The fighting is over whether hunter-gatherer communities in recent centuries have tended more toward war -- defined as banding together in groups to kill people in other populations -- than toward one-on-one attacks within their own communities. A second front has broken out over how to extrapolate from modern behavior to the Stone Age. Some anthropologists regard the nomadic groups as helpful if imperfect models of Stone Age human behavior. Others suspect that too much evolutionary change and irregular contact with outsiders make hunter-gatherers unreliable signposts of the past.

Lethal attacks on one community by another rarely occurred during the 19th and 20th centuries, according to a new analysis of data previously gathered from nomadic hunter-gatherer populations. Murders of one person by another in the same group accounted for a majority of intentionally caused deaths, anthropologists Douglas Fry and Patrik Söderberg of Åbo Akademi University in Vasa, Finland, report in the July 19 Science.

Ten of the hunter-gatherer groups had no recorded killings involving more than one attacker, effectively making those societies no-war zones, Fry and Söderberg say.

The new evidence suggests that humans have evolved a tendency to avoid killing in general, the researchers contend. War originated only within the past 10,000 years, in their view, with armed conflicts intensifying as the first states expanded between 6,000 and 4,000 years ago.

"Fry and Söderberg go against the popular tide in science ... and win hands down," says anthropologist R. Brian Ferguson of Rutgers University in Newark, N.J.

Archaeological evidence from Europe, the Middle East and western Asia contains relatively few signs of murder and war until after 10,000 years ago, he says.

But the new study has attracted fire from other investigators. "Fry and Söderberg use the hunter-gatherer record inappropriately to push the idea that because many modern hunter-gatherers were not seen to have war, ancestral hunter-gatherers also did not often have war," says Harvard anthropologist Richard Wrangham.

Wrangham and others say that the new paper ignores relatively high homicide rates previously documented in hunter-gatherer groups, including some in the study. Critics also point to reports of regular fighting among neighboring hunter-gatherer communities; the groups that Fry and Söderberg studied were largely isolated. From critics' perspective, war probably goes back tens of thousands of years and stoked the evolution of intense cooperation within, but not between, human groups.

Murders cause more deaths than war in both traditional and modern societies, with exceptions coming during the 20th century's two world wars, says Harvard University psychologist Steven Pinker. Given war's rarity, researchers are unlikely to observe raids and other attacks on rival groups when studying small hunter-gatherer samples such as those in the new study, he says. Rates of violent death are higher among hunter-gatherers and in other non-state societies than in state societies, he adds.

A cross-cultural analysis found that nomadic hunter-gatherer populations rarely organize to attack other groups, with the exception of members of Australia's indigenous Tiwi society.

Fry and Söderberg's finding that mobile hunter-gatherer bands infrequently organize warlike attacks does not surprise anthropologist Polly Wiessner of the University of Utah. But raiding and war does take place in a few such groups, as well as among sedentary hunter-gatherers that live year-round in bountiful settings near coasts or rivers. The great unanswered question, Wiessner says, concerns "how different societies harnessed and tamed aggression to build larger societies throughout human evolution."

Fry and Söderberg identified data on 148 killings in 21 mobile hunter-gatherer groups. Just over half of those killings were committed by lone perpetrators. Almost two-thirds resulted from disputes within families, executions of group members, competition among men over women and other conflicts within groups.

About one-third of killings involved attacks by one group on another. Reasons included disputes over resources, thefts of women and revenge attacks for past stealing or other offenses.

Australia's Tiwi had an exceptionally large number of killings, 69, and accounted for most of the lethal attacks across groups.

Economist Samuel Bowles of New Mexico's Santa Fe Institute criticizes Fry and Söderberg for choosing relatively peaceful groups, including the Tiwi, that mostly live in places where state-run armies discourage intergroup conflict. In his 2009 analysis of eight hunter-gatherer societies, the Tiwi ranked near the bottom in estimated rates of war-related deaths. None of the other seven groups he studied were part of Fry and Söderberg's work.

A handful of reports have likewise found fairly regular, usually low-level warfare among neighboring hunter-gatherer societies, Wrangham says. In those cases, hunter-gatherers had little or no contact with more powerful farming communities that could have discouraged fighting. Warring groups had different customs and spoke different languages or dialects. Fry and Söderberg mainly addressed conflicts between bands of hunter-gatherers with common customs and languages, which reveal little about the evolution of war, Wrangham contends.

Wrangham considers periodically warring hunter-gatherer groups to be the best available models of Stone Age practices. In a 2012 paper, he and a colleague proposed that ancient people in groups such as these evolved a tendency for males to band together and opportunistically kill members of rival groups -- much as chimpanzees do.

Source: **Science News**

BIG LEAP

World changing technology crop

A major new technology has been developed by The University of Nottingham, which enables all of the world's crops to take nitrogen from the air rather than expensive and environmentally damaging fertilisers.

Nitrogen fixation, the process by which nitrogen is converted to ammonia, is vital for plants to survive and grow. However, only a very small number of plants, most notably legumes (such as peas, beans and lentils) have the ability to fix nitrogen from the atmosphere with the help of nitrogen fixing bacteria. The vast majority of plants have to obtain nitrogen from the soil, and for most crops currently being grown across the world, this also means a reliance on synthetic nitrogen fertiliser.

Professor Edward Cocking, Director of The University of Nottingham's Centre for Crop Nitrogen Fixation, has developed a unique method of putting nitrogen-fixing bacteria into the cells of plant roots. His major breakthrough came when he found a specific strain of nitrogen-fixing bacteria in sugar-cane which he discovered could intracellularly colonise all major crop plants. This ground-breaking development potentially provides every cell in the plant with the ability to fix atmospheric nitrogen. The implications for agriculture are enormous as this new technology can provide much of the plant's nitrogen needs.

A leading world expert in nitrogen and plant science, Professor Cocking has long recognised that there is a critical need to reduce nitrogen pollution caused by nitrogen based fertilisers. Nitrate pollution is a major problem as is also the pollution of the atmosphere by ammonia and oxides of nitrogen.

In addition, nitrate pollution is a health hazard and also causes oxygen-depleted 'dead zones' in our waterways and oceans. A recent study estimates that that the annual cost of damage caused by nitrogen pollution across Europe is £60 billion -- £280 billion a year.

Speaking about the technology, which is known as 'N-Fix', Professor Cocking said: "Helping plants to naturally obtain the nitrogen they need is a key aspect of World Food Security. The world needs to unhook itself from its ever increasing reliance on synthetic nitrogen fertilisers produced from fossil fuels with its high economic costs, its pollution of the environment and its high energy costs." N-Fix is neither genetic modification nor bio-engineering. It is a naturally occurring nitrogen fixing bacteria which takes up and uses nitrogen from the air. Applied to the cells of plants (intra-cellular) via the seed, it provides every cell in the plant with the ability to fix nitrogen. Plant seeds are coated with these bacteria in order to create a symbiotic, mutually beneficial relationship and naturally produce nitrogen.

N-Fix is a natural nitrogen seed coating that provides a sustainable solution to fertiliser overuse and Nitrogen pollution. It is environmentally friendly and can be applied to all crops. Over the last 10 years, The University of Nottingham has conducted a series of extensive research programmes which have established proof of principal of the technology in the laboratory, growth rooms and glasshouses.

The University of Nottingham's Plant and Crop Sciences Division is internationally acclaimed as a centre for fundamental and applied research, underpinning its understanding of agriculture, food production and quality, and the natural environment. It also has one of the largest communities of plant scientists in the UK.

Dr Susan Huxtable, Director of Intellectual Property Commercialisation at The University of Nottingham, believes that the N-Fix technology has significant implications for agriculture, she said: "There is a substantial global market for the N-Fix technology, as it can be applied globally to all crops. N-Fix has the power to transform agriculture, while at the same time offering a significant cost benefit to the grower through the savings that they will make in the reduced costs of fertilisers. It is a great example of how University research can have a world-changing impact." The N-Fix technology has been licensed by The University of Nottingham to Azotic Technologies Ltd to develop and commercialise N-Fix globally on its behalf for all crop species.

Peter Blezard, CEO of Azotic Technologies added: "Agriculture has to change and N-Fix can make a real and positive contribution to that change. It has enormous potential to help feed more people in many of the poorer parts of the world, while at the same time, dramatically reducing the amount of synthetic nitrogen produced in the world."

The proof of concept has already been demonstrated. The uptake and fixation of nitrogen in a range of crop species has been proven to work in the laboratory and Azotic is now working on field trials in order to produce robust efficacy data. This will be followed by seeking regulatory approval for N-Fix initially in the UK, Europe, USA, Canada and Brazil, with more countries to follow.

It is anticipated that the N-Fix technology will be commercially available within the next two to three years.

Source: **Science Daily**

ACROSS
1 Flourish
6 "Rabbit, Run" author
12 Tearjerker
13 Construction piece
14 "Anna Christie" playwright
15 Coats
16 Lima's place
17 Father of Thor
19 Away from WSW
20 Style
22 Lummox
24 Most Wanted List org.
27 Elite alternative
29 Bart's sister
32 Lincoln's election year
35 Region
36 Location
37 Storm center
38 Inseparable
40 Osso buco base
42 A cont.
44 Level
46 Apiece
50 Boardroom props
52 Prophet
54 Half a storybook duo
55 "My heavens!"
56 Clothing
57 Unlike a rolling stone?

DOWN
1 Part of N.B.
2 Lecherous look
3 Poppy drug
4 Lubricate
5 Tunes
6 Wrinkly fruit
7 Challenge for Laurel and Hardy in "The Music Box"
8 Saharan
9 Obsession
10 "Show Boat" composer
11 Gaelic
12 Doo- — music
18 Fool
21 Make a choice, with "for"
23 "The Greatest"
24 Shriner's chapeau
25 Life story, for short
26 Unknowing
28 Waiting area
30 Pigpen
31 Nay canceler
33 Coop denizen
34 Multitude
39 Old anesthetic
41 Starts
42 Turkish potentate
43 "Animal House" group
45 Capri or Wight
47 Dogfight participants
48 23-Down's old name
49 The lady
51 Sixth letter after 53-Down
53 See 51-Down

Solution time: 27 mins.

M	O	T		S	A	F	E		B	I	D	S
A	R	E		T	R	I	P		L	O	R	E
J	A	M	B	O	R	E	E		O	N	Y	X
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			S	K	Y		G	A	M	B	O	L
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B	A	M	B	O	O		C	A	M			
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S	P	U	R		C	A	M	B	O	D	I	A
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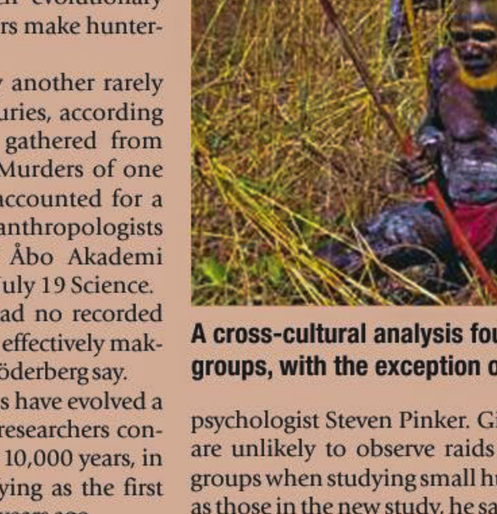
Y	E	A	H		O	L	L	A		T	E	E

Yesterday's answer 6-22



CRYPTOQUIP

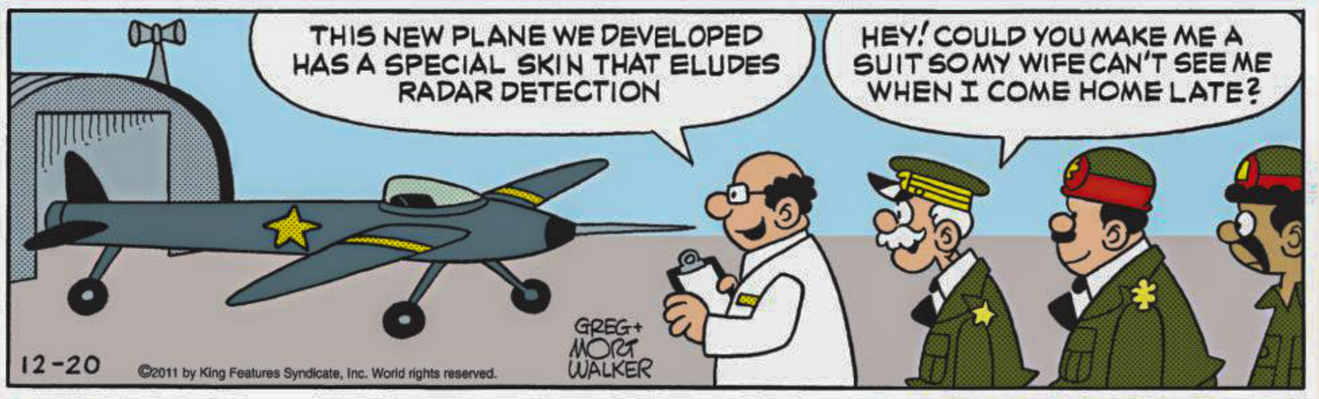
MEVXR WIU MEIUGUI SIDTYF SE SIWPX CELY HD AEHU. DEB LEBVC SATYX T'H VTGTYF TY W ABYSUC AEBRU.

Yesterday's Cryptoquip:

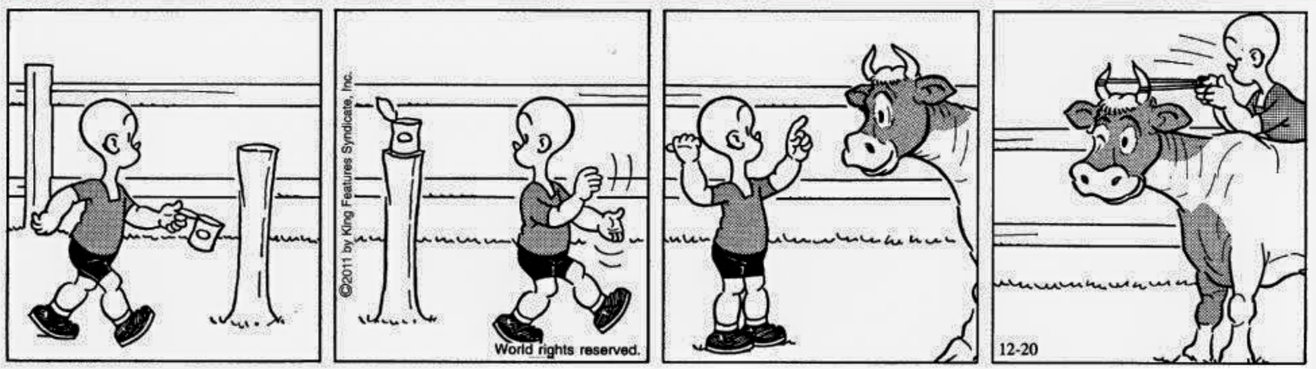
AT THE BELT FACTORY, THE BOSS WARNED MANY SLOTHFUL WORKERS THAT IT WAS TIME TO BUCKLE DOWN.

Today's Cryptoquip Clue: T equals I

BEETLE BAILY by Mort Walker



HENRY by Don Tranchte



QUOTABLE *Quotes*

"Politics is perhaps the only profession for which no preparation is thought necessary."

Robert Louis Stevenson