Toilet Science
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When I am asked what my latest work is and I have to say honestly, I would tell that I am working on what I call “toilet science”. My friend may be abhorred to hear this or chuckle at my words perhaps sounding humorous? When he frowns at these words, I would tell him that “toilet” may be dirty, but toilet cleans dirty wastes and thus it cleans mess up and certainly “toilet science” is thus clean and “cleanup science”.

Homo sapiens had a superior capability of cooperative intelligence over Neandertal, in spite of the fact that the latter had, I learned, a greater brain weight and superior body framework. This cooperative intelligence including the more sophisticated communication skills to make Homo Sapien troupe to communicate among themselves better and more in a cohesive fashion as compared with the Neandertal. Apparently, this skill of our ancestors made them eventually won over the latter. Moreover, our ancestors were able to spread their habitual places over all Continents except for the Antarctica crossing wide oceans and arctic severity of cold. They were able to manage to harvest more food and shelters with their unprecedented skill. Now we see ourselves prosper as the most successful species on the surface of the Earth with billions of our sisterhood.

Our ancestors had extremely successful kitchen technology in order for them to eat, including the invention of fire and knife. No animal rivaled us. Every civilization managed to be equipped with ‘kitchen’. However, our ancestors had been slow to come up with toilet. I am not an archeologist and I have no precise idea about our ancestors’ toilet. But I often read about how dirty our medieval and even post-industrial revolution cities had been, as they lacked adequate toilets in these relatively latest civilizations of ours. In fact in part due to this lack of adequate toilets in our ancestral cities, epidemic diseases so often spread and catastrophic population declines had repeated. Fast forward to my own generation. In the post WW II Japan, when I was a child (probably 5 or 6 years old), I recall to have walked our dog near our house in the large and well-known historic city of Osaka. At that time of Japan, the Japanese toilet did not have water swooping technology, but rather our excretions were collected by large buckets and stored nearby farm holes. This is so-to-speak man’s ingenious “brown” (if not quite “green”) recycle of reusable resources of human wastes to farm soil to cultivate vegetables. Alas, our little poor dog did not realize this brown little pool is not to be entered (or its lid slipped open). After he accidentally fell into this pool and we rescued and washed him from it, he eventually passed away in a few days, perhaps due to pneumonia. This was an isolated little tragedy of our dog. However, when I entered an elementary school, every kid needs to periodically bring our excretions to be examined if we had harbored parasites in our intestine, as our vegetables thus harvested may have contained eggs of roundworms. This epidemiological issue ceased to end only when the Japanese toilet had become flush toilet of what we now get used to (it took only several years since our dog’s episode). Now the toilet was as sparkling as the kitchen was. This revolution took place only a half century ago when I was of about age 12.

Homo sapiens seems to have been slow to notice in “toilet” or waste management. Not just above only. Our ancestors pioneered the industrial revolution by coal and further made quantum jump by the introduction of the petroleum civilization later (i.e. now). Our life upstream is so convenient and fast, while our downstream of its waste CO₂ has not been managed yet to this day. My life long research on fusion science and technology may be one of such approach to reduce excretion of CO₂ waste into air. However, our society does not seem to have reached a
consensus that this is in fact a toiletless situation. Even before fusion research began in earnest, the fission energy was kindled by Enrico Fermi in 1940. At a remarkably fast development pace of nuclear energy in a mere decade since the human discovery of fissile nuclei. The nuclear era dawned brightly and fast and the nuclear “kitchen” was bright, spectacular, sparkling, abundant, and promising to overcome the fission fuel waste issue, as it produces no or little CO2. Alas, the burning of the Uranium fuel as a fissile fuel brings about radioactive waste, such as Pu, Minor Actinides (MA’s) and fission products (FP’s). Our civilization has not found a well-established method to manage these nuclear wastes other than (propose to) dump these wastes in deep geological layers. But because of the geologically long radioactivity, no clear sites have been chosen. One of the prestigious newspapers (Asahi Shimbun in Japan) called this situation in its recent Editorial as “Look directly at the situation of nuclear waste treatment: Nukes without Toilets” (July 31, 2017). See attached (in Japanese).

However, we (Dr. A. Necas, Dr. G. Mourou, Dr. S. Gales, Dr. M. Leroy, and I) are very happy that recently we seem to have found a pathway how to manage highly radiotoxic MA’s of nuclear waste by the transmutation method we invented. If this turns out to be effective, we may have invented a toilet for the nuke wastes and thus we may be really “toilet-sciencing” for nuke wastes.

Another avenue of our “toilet science” is the beam dump of high energy accelerators. In a modern high energy physics, it is customary to accelerate charged particles to extremely high energies (we call these as high energy beams). We then collide each beam with another high energy beam, which is thus called a collider. In the past colliders have discovered many new particles and thus new physics of elementary particles. As the frontier gets ever higher energies, the beams need to be extremely of high energies. The issue of the “kitchen” side is to produce ever higher energies and thus our “kitchen” has to become a powerhouse. The problem remains, however, that the beam waste remains of so high energies that our beam dump must be mile long and the beam dump materials get radioactivated by the high energy beams. Again a serious “toilet” issue. My colleagues (including Dr. H. Wu, Dr. A. Chao, and myself) invented a simple, cheap, inverse accelerator (we call wakefield decelerator) by a gas tube. This method has been already shown to work in the case of laser accelerated beam dump.

The homo sapiens (HS) aspiration is boundless so that it went beyond the Earth, i.e., space, since the Sputnik in 1957. The space “kitchen” looks so gorgeous and totally pristine, as not much in space, as space is (near) empty. However, since Sputnik man has launched so many satellites so that our space is filled with so many space debris now. It is exponentiating so rapidly that we are now afraid that astronauts and / or satellites in orbit may be soon or later hit by debris. A very precarious situation. Again, man was quick and ingenious to launch space satellites, but unable (or not willing to) manage space debris. Our colleagues (including Dr. G. Mourou, Dr. S. Ebisuzaki) have invented a laser (called the CAN laser with light and extremely high repetition rate) so that we can space-survey to detect the space debris and catalogue these. Here recognizing and sweeping debris is done by our “toilet” capability of the CAN laser.

I would be ecstatic if our modest effort to remind HS and to advance “toilet science” makes a tiny dent in our wastes.
“Look directly at the situation of nuclear wastes treatment: Nukes without Toilets”

Regarding final disposal site of high level radioactive waste (nuclear waste) emitted from nuclear spent fuel, the government announced "scientific property map".

From the natural conditions such as the presence of volcanoes, active faults and underground resources, the whole country is classified into four categories, "preferable" and "undesirable". Some people may be interested in municipalities that have homes or hometowns.

Peace of mind, worry, vigilance ... .... As much as 60% of the total land is considered "preferable", it may have been passed as a person, "My place is irrelevant".

Not someone else’s

I want to think again about what the maps ask.

A half century has passed since the operation of commercial nuclear power plants in Japan began. We have nearly 20 thousand tons of spent fuel.

The high-level radioactive waste emitted from the fuel takes tens of thousands to 100 thousands of years before the radioactivity falls to a sufficiently safe level. So, bring it to a deeper stratum than underground 300 meters, fill the tunnel, close it, leave it to nature. That is the final disposition the government thinks.

Although it is a challenging problem that affects a tremendous future that goes beyond human imagination, it cannot be avoided. Nevertheless, using the electricity generated by nuclear power while obscuring the disposition, we have enjoyed only the benefits. It is because the nuclear power plant can be regarded as an apartment without a toilet.

I can not put off forever. Map puts that heavy reality to every citizen.

Public invitation to accept survey began in 2002. In 2007 Oriental Town in Kochi Prefecture handed up, but withdrew from the resident's rebellion. According to the new basic policy decided by the Cabinet two years ago, the government says, "The country is working in front of it and will cooperate with the municipality for investigation."

But there is a fundamental question. It is trying to promote the final disposal site problem on the premise of maintaining and continuing the current nuclear policy.

Way out of nuclear power plants and learn from the past

Reprocess spent fuel to remove plutonium and uranium and use it for fuel. Fill the remaining waste with glass and fill it in the final disposal area. This is an outline of nuclear fuel cycle.

However, the failure of the cycle business is obvious. It is symbolized by the fast breeder reactor "Monju" which was driven into the decommissioning furnace due to the continuation of failure, while investing over 1 trillion yen.

Finland and Sweden where the final disposal site has been decided adopt "direct disposal" that fills spent fuel as waste as it is. Japan should react realistically.

And if you move the nuclear power plant, you must face the fact that spent fuel will also increase.

Although the map was made, even if the candidate site is found, the final disposal will take about 20 years only by investigation. In order not to increase spent fuel as much as possible, it is indispensable to show the path to departure in parallel.

It is worth considering the idea that the upper limit of the amount of waste to be disposed is determined and that the nuclear power plant will not be operated any further. In order to secure a final disposal site to protect nuclear plants, public understanding will not be obtained. The Ministry of Economy, Trade and Industry and the Nuclear Power Generation Environment Improvement Organization will work on dialogue centering on the area on the sea side,
which is said to be "also favorable in terms of transportation", and make full-scale search for candidate sites for investigation.

I have an order. Explain the risks and uncertainties assumed over the final disposal site without covering up. And do not adopt such a method as to demand acceptance in exchange for economic benefits and regional promotion. Learn from past lessons

The Ministry of Economy, Trade and Industry and the Organization repeated the simulation results after 100 thousand years, repeatedly saying "(the waste is buried in the ground) geologic disposal is technically established" at the general briefing session or the like prior to the map announcement While emphasizing safety enough.

However, even if we take every possible measure, the risk will not be zero. It is the lesson of the Fukushima Daiichi nuclear accident to break away from "safety myth".

Unlike Europe and the United States, the Japanese archipelago has many volcanoes and earthquakes. Regarding the final disposal, the Science Council of Japan pointed out in 12 years that "It is impossible for current scientific knowledge and technical ability to ascertain a stable stratum over a very long time spanning a million years."

As for the municipalities that accept the survey, the grant of up to 2 billion yen in the first literature survey and up to 7 billion yen by the next overview survey will be included. It would be an attractive amount for local governments.

In the former nuclear power station, the grant in exchange for acceptance brought various local merits and demerits. The acceptance of final disposal sites is a heavy judgment related to the generation of the distant future, which is tens of thousands of years ahead, compared with the nuclear power plant which will be shut down within 100 years even to the waste furnace. It is increasingly important to not only lead with a temporary economic merit, but also to make efforts to consent.

Selection of disposal sites is inseparable from nuclear power policy, and it will not proceed unless there is public trust in policy. Since trust in nuclear power plants has been lost in the accident in Fukushima, a drastic review of policies is indispensable

(Google translate)