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Plasma arc disposal of radioactive waste

While the use of plasma arc disposal of radioactive waste has been around for some time it has yet to be widely embraced by the nuclear power industry. It's hard to understand why, considering it's a fairly straight-forward and proven technology to reduce low and medium level radioactive waste to a minimal volume for safe disposal. Nuclear Exchange talked to Mr. Ihar Khvedchyn, Vice President, Head of R&D and Plasma Engineering and Mr. Vladimir Miloslavine Vice President, from High Temperature Technologies Corp. Canada, about this promising technology.

By Joanne McIntyre

During the operation of nuclear power plants and in the commercial and research facilities of industries around the globe, large amounts of solid and liquid radioactive waste (RW) are accumulated. The use of low-temperature plasma technology for the treatment of RW makes it possible to achieve highly stable forms of processed products, with high chemical resistance to aggressive environmental influences. The technology is both promising and relatively simple. Basically the waste is blasted inside a closed furnace with a plasma arc until everything except the residual, concentrated radioactive material remains. This low volume residue can then be safely packaged and disposed of in a permanent depository.

Key advantages

"There are several key advantages to employing this technology for RW disposal," explains Ihar. The main advantages are:

- the possibility to achieve highly specific performance with a small piece of equipment;
- the ability to create the desired gas atmosphere in the reactor to process various types of waste without needing it to be pre-sorted;
- a greater reduction in the volume of RW and flue gases;
- the end-products in the form of re-melted ash or a slag compound have a high chemical resistance to aggressive environmental influences.

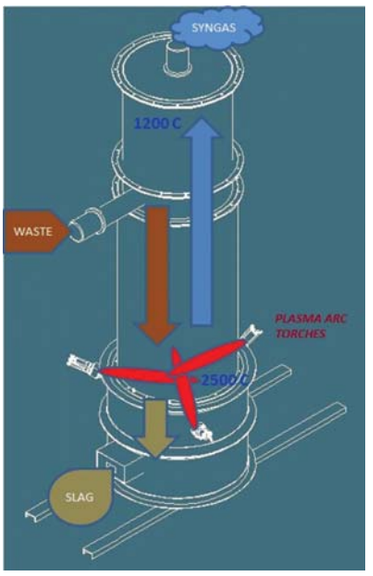
The company uses plasma arc torches ranging in power from 50 kW to 500 kW, which are the main key element of its plasma furnaces with a capacity of up to 500 kg/h. Such plasma furnaces can treat any organic waste, such as solid waste, biomass, medical waste, chemical waste, etc.

The low-temperature plasma technology is suitable for the treatment of both solid and liquid radioactive waste of low-level and intermediate-level of activity, such as fabric, paper, plastic, wood, process fluids, clothing, shoes, wires, etc. It is not suitable for spent nuclear fuel (high-level of activity).

"Every year, operators of nuclear reactors end up with a lot of products such as used clothing and shoes, etc. which have gained a critical level of radiation and need to be safely disposed of. These types of items can be efficiently destroyed in a plasma reactor," says Ihar.

The transformation of waste

The treatment of radioactive waste in the plasma reactor transforms it in several stages. These are:



A diagram of the internal structure of the plasma reactor (left) and a photo of a reactor.

- Gasification of RW (incomplete evaporation and output of volatile components);
- Pyrolysis of the organic part of the RW with subsequent purification of the pyrolysis gas and its homogeneous combustion in the chamber;
- Burning of the coke residue;
- Melting of the ash and incombustible impurities resulting in the creation of a chemically and mechanically resistant slag with a high radionuclide content.

"As a result of plasma disposal process, the volume of waste is reduced by 10-15 times, and the radionuclides are concentrated," explains Ihar. "The radionuclides are safely immobilized in the resulting product and cannot leach into the environment. After the treatment of the RW is finalized, the inert slag is then disposed of in the normal way – burial or long term storage."

Practical application

While HTT has not yet made a full economic analysis of the plasma method of RW disposal, the estimated calculations give comparable prices with the classical methods used while producing higher environmental parameters. "Other existing methods used for treating solid combustible and noncombustible RW such as incineration, compaction and the evaporation of liquid inorganic RW do not guarantee a reliable localization of the radionuclides due to the poor physical and chemical characteristics of processed products (ash, bricks, salt), obtained as result of these processes. By contrast the plasma method produces a stable, homogenous, inert product which is easier to dispose of and takes up 10 to 15 times less volume."

The plasma method is already being applied at the Smolensk and Novovoronezh nuclear power plants in Russia, explains Vladimir. "A project to develop plasma reactor for nuclear power plants in Belgium has also been started; and currently the use of this technology is being negotiated in nuclear plants in both Bulgaria and the Ukraine."

Given the benefits of the technology one can't help but wonder why this method has not yet been embraced more widely. However Vladimir is not surprised. "Any new method or technology always passes through difficult stages of disbelief, doubt, and repeated testing until it receives industrial recognition. This is especially true in the nuclear industry, where the introduction of new standards requires a very complex and time-consuming procedure of adoption."

However it seems clear that the technology is likely to be increasingly employed in the future.

HTT uses plasma arc torches ranging in power from 50 kW to 500 kW to process a wide range of waste products.