

# **ACCELERATOR MOLTEN SALT BREEDER**

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Several scientific teams propose a new way of energy production, grounded on the spallation of heavy nuclei by their interaction with high energy Protons produced by accelerators. The nuclear problem due to long half-life and high toxicity waste (fission products and minor actinides from the Uranium-Plutonium fuel cycle), should be solved by the same manner,

From now, we can guess that the development of this new nuclear technology, will be faced to difficulties similar to those met by the present nuclear industry since fifty years, and not yet totally overpassed; besides the conception & build up of **high performance accelerator (1 GeV, 300 mA)**, the collection of physical nuclear data, many other features have to be defined: the physical and chemical composition of the target, its fabrication process, the type of cladding and structure materials, the heat transfer process, the handling, cooling and reprocessing of the target, the technical and political management of waste, and new fissile material to be recycled...etc. The safety in operation of these transmutation facilities cannot be warranted from now...

We may fear that the challenge to supply safely Humanity -by 2010 to 2020- the huge energy needs, is already lost...except if a strong reduction of the present nuclear waste production is undertaken, and if we use the large theoretical and technical knowledge gathered initially in the Oak Ridge National Laboratory, and elsewhere after (Japan, Russia, India, France...) with the Molten-Salt Reactor studies.

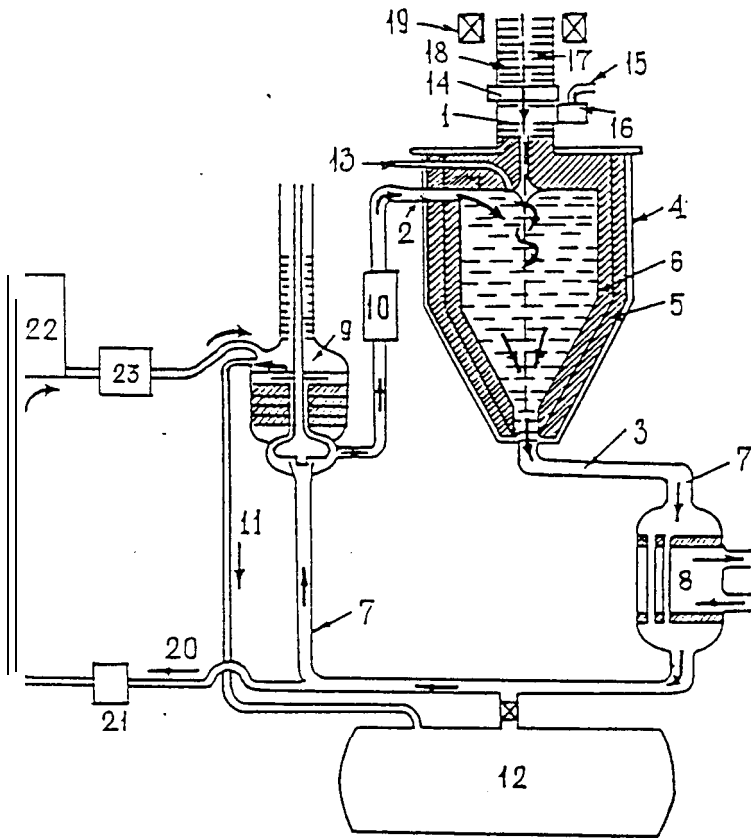
The Accelerator Molten Salt Breeder (AMSB) invented in 1981 by K. FURUKAWA et al., is one part of a global strategy aiming to produce 900 TWe/year along more than one century; Thorium is the most suitable material; Molten Fluorides are the Fissile-Fertile link between the Burners Reactors operated by utilities, and the AMSBs settled under the international authorities; the chemical treatment of all nuclear materials (except ores) is realized by the "Dry Process" well known in France and elsewhere.

This Accelerator Molten Salt Breeder project uses the specific feature of Spallation, which is to produce many neutrons and few energy (in opposition to fission). The high density neutrons source can be used to destroy and/or transmute the Fission Waste (Plutonium, minor Actinides, high half-lives Fission Products). Also, it can be selected to produce the huge amount of Fissile materials needed for the next century. In this concept, the Accelerator facility is designed to be only self-sustaining in energy.

The figure here-after, shows the target wherein the protons beam induces the spallation process on the heavy nuclei. Neither the linear Accelerator (LINAC) which will be the same for any design, nor the electricity production (already described in ORNL reports) are presented,

The nickel alloy named Hastelloy N, conceived initially for the building of Molten Salt reactor vessel, exchangers, pumps, valves, ...etc, suits perfectly to the technical features of the target.

Set-up of single-fluid type  
Ace. Molten Salt Breeder



- 1- Proton beam,
- 2- Salt inlet,
- 3- Salt outlet,
- 4- Reactor vessel,
- 5-6- Graphite,
- 7- Primary loop,
- 8- Heat exchanger,
- 9- Main Salt pump,
- 10- Throttle valve,
- 11- Overflow line,
- 12- Storage tank,"
- 13- Pressured salt inlet,
- 14- Gate valve,
- 15- Vacuum line,
- 16- Vapor trap,
- 17- Duct,
- 18- Orifice,
- 19- Focussing magnet,
- 20- Bypass for salt purification,
- 21- Pump for bypass line,
- 22- Process facility,
- 23- Filter.

The liquid state of the target, made of Fluorides salts, and of which the physical and chemical properties have been studied by the MS community, brings some practical interesting features:

- due to its low concentration of heavy nuclei, it makes easier the entry of the protons beam into the target vessel, and helps the scattering of the induced particles.
- its chemical flexibility allows to fit the salt composition to the economical and political needs: transmutation and/or destruction of Fission Products, Actinides, or breeding of Fissile Materials.
- its weak vapor pressure makes the window beam problem simpler to solve.
- the salt reprocessing chemistry is well mastered.

In the following Table are given the calculations results of an AMSB target designed for the breeding of  $^{233}\text{U}$  from  $^{232}\text{Th}$ , and simultaneous destruction of High Grade Plutonium.

Table -  $^{233}\text{U}$  Production.  $^{239}\text{Pu}$  Transmutation & Power-Generation in AMSB separating  $^{233}\text{U}$ -increment in One-year Interval.

Fuel Composition:  $7\text{LiF}-\text{BeF}_2-\text{ThF}_4-^{233}\text{UF}_4-^{239}\text{PuF}_3$ . 64-18- [18-(X+Y)] -X-Y mol%  
[system-size]: 4.5 M in diameter, 6 M in depth

	X=0.1		X=0.2		X=0.3		X=0.4		x=0.6 X=0.3	
	Y=0.5	0.7	0.5	0.7	0.5	0.7	0.5	0.7	0.7	0.7
multiplication factor:	.56	.62	.61	.66	.66	.70	.69	.7A	.81	.88
$^{232}\text{Th}$ loading. Mg:	129	128	128	127	128	126	127	125	124	123
fissile inventory, 'g'										
$^{233}\text{U}$	746	746	1490	1490	2240	2240	2980	2980	4478	5970
$^{239}\text{Pu}$	3824	5350	3824	5350	3824	5350	3824	5350	5350	5350
'net $^{233}\text{U}$ prod., Kg/y:	657	730	671	744	682	762	695	785	840	905
$^{239}\text{Pu}$ decrease. Kg/y:										
[capture & fission]	215	308	227	329	241	355	259	385	470	610
total fiss. prod., Kg/y:	363	565	432	525	514	665	614	748	1095	1670
total output. MWe:	386	470	464	564	555	67A	665	805	1182	1810

[mean in one year operation]