

generating unit can be built according to various schemes - from a low-pressure turbine to a reciprocating steam engine, or an air-heat Stirling machine.

(5) Minimum technical complexity and price for the disposal of spent nuclear fuel of nuclear fuel storage facilities, subject to reasonable environmental protection requirements.

SNF can be disposed of in the open sea through the production of concrete monoliths from a dry mix delivered from the shore and an aqueous solution discharged from the core. After curing, the monolith can be flooded at depths of 2000 meters, without any consequences for the exploited biological marine resources, and without any risk to personnel and passengers on high seas ships.

(6) The minimum technological complexity of the synthesis of the target chemical product, the minimum biological and technical hazard of the product, the minimum transportation requirements. Maximum product versatility when using it.

In the proposed concept, it is formic acid, which is synthesized electrochemically from water and atmospheric CO₂. The technology for the production of formic acid by fixing CO₂ with alkali in an aqueous bicarbonate solution, and subsequent electrolysis reduction, has been known since 1869. Today, a number of advanced technologies are known. but this does not change the essence of the matter. Formic acid is safe to transport and can be used:

- As a transit hydrogen accumulator for use in hydrogen energy.

- For the synthesis of ersatz gasoline in a modified Fischer-Tropsch process.

- By itself, as an energy carrier for fuel cells.

(7) Additional options NChSF having high socially positive value and good PR.



Figure 4. FNPP “Academician Lomonosov”

In this regard, it is proposed to equip NChSF with a simple desalination plant. Corresponding experience is available for FNPP “Academician Lomonosov” (Figure 4):

Productivity 240,000 cubic meters of fresh water per day (with a thermal capacity of 300 MW).

7. CONCLUSIONS

The paper outlines approach that provides the solution to the

following cardinal tasks in the framework of creating an autonomous power plant with a carbon balance close to zero:

(1) Production of hydrogen fuel without the need for high temperature installation.

(2) Solving the problem of transporting and storing hydrogen using formic acid.

(3) Usage of the floating Nuclear Chemical - Synthetic Facility (NChSF) of the open sea.

Not being located in the inhabited territory, or in the coastal waters, such NChSF have not safety problems. NChSF does not deliver the generated energy by power transmission lines, but by synthesizing and shipping a convenient, safe and reasonably versatile energy carrier that is produced at NChSF.

In the proposed concept, it is formic acid, which is synthesized electrochemically from water and atmospheric CO₂.

This facility uses mainly cheap and / or common types of nuclear fuel and permits to have closed nuclear cycle.

Besides NChSF system can be used for the synthesis of ersatz gasoline in a modified Fischer-Tropsch process.

REFERENCES

- [1] Gotovsky, M., Gotovsky, A., Mikhailov, V., Kolpakov, S., Lychakov, V., Sukhorukov, Y. (2018). Formic acid cycle as partial alternative to Allam cycle less expensive and simpler. *TI-IJES*, 61+1(2): 49-54.
- [2] Gotovsky, M., Gotovsky, A., Mikhailov, V., Kolpakov, S., Lychakov, V., Sukhorukov, Y., Sukhorukova, E. (2019). Formate FT-process for producing traditional energy carriers with zero carbon balance. *WIT Transactions on Ecology and the Environment*, 237: 155-162. <https://doi.org/10.2495/ESUS190141>
- [3] Gotovsky, M., Gotovsky, A., Mikhailov, V., Lychakov, V., Sukhorukov, Y., Sukhorukova, E. (2019). Formate cycle ICEBE 2019. *Conference Abstracts, Singapore*, p. 29.
- [4] Watkins, J.D., Bocarsly, A.B. (2014). Direct reduction of carbon dioxide to formate in high-gas-capacity ionic liquids at post-transition-metal electrodes. *Chemsuschem*, 7(1): 284-290. <https://doi.org/10.1002/cssc.201300659>
- [5] Boddien, A., Mellmann, D., Gartner, F., Jackstell, R., Junge, H., Dyson, P.J., Laurenczy, G., Ludwig, R., Beller, M. (2011). Efficient dehydrogenation of formic acid using an iron catalyst. *Science*, 333(6050): 1733-1736. <https://doi.org/10.1126/science.1206613>
- [6] Aristova, N.A., Piskarev, I.M., Ivanovsky, A.V., Selemir, V.D., Spirov, G.M., Shlepin, S.I. (2004). Initiation of chemical reactions under the influence of electric discharge solid dielectric system - gas – liquid. *Journal of Physical Chemistry*, 78(7): 1326-1331.
- [7] Fernandez, R., Mandrillon, P., Rubio, J.A., Rubbia, C. (1996). A preliminary estimate of the economic impact of the energy amplifier. *European Organization for Nuclear Research. CERN/LMS/96-01 (EET)*. <http://cds.cern.ch/record/297967>