Non-electric applications of nuclear energy

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Introduction

The need for energy around the world is tremendously increasing. The prices fluctuations of fossil fuel, in addition to its impact on environment and more importantly its finite resources, all these factors together, make nuclear energy good alternate to meet the growing demand for energy.

Although nuclear energy has been used in providing electricity, it only provides about 10 % of the global electricity generation. However, the electricity represents only less than one third of the world energy uses and about two third of this energy is wasted as heat. Therefore, if it is possible to utilize this wasted heat, then this will optimize the production of electricity as well as the energy need for non-electric applications [1].

Nuclear energy can be used in many non-electric applications;

- desalination of salty and waste water,
- district heating of residence and commercial buildings in cold countries,
- industrial process heat supply,
- fuel synthesis.

Nuclear desalination of salty and waste water

Water is the secret of life but recently there are many concerns raised because of human populations are increasing and consequently the need for water has dramatically increased. About 94% of the world's water is salt water and only 6% is fresh, and less than 1% of the fresh water is easily accessible [3]. The world Economic Forum says the shortage of fresh water might represent the primary threat in the next decade.

Desalination is the separate of minerals and salts from a target substance. Nuclear desalination is the production of potable water from seawater or brackish water in which a nuclear reactor is used as the source of energy for the desalination process.

Desalination of sea water is costly because it is energy consuming process, but nuclear energy has been considered as a viable option in reducing the financial cost and providing sustainable supply of energy.

Feasibility

The feasibility of nuclear desalination was realized as early as 1960s. Currently, with experience of 200 reactors-years operating, the nuclear desalination as viable option to meet the global energy demand for energy. Many countries across the world have already planned to adopt nuclear desalination of water; for example Morocco has planned with china at Tan-tan on the Atlantic coast to produce 8000 m^3 / day of potable water. Egypt also plans two nuclear power plant with desalination facility (MED &RO), each produce 170,000 m^3 /day [2]. The table [1] shows nuclear plants that have been used for desalination of water [3].

There are two main processes of desalination:

Thermal desalination:

In this process of desalination, heat is used to vaporize and distill fresh water from saline water through multi-stage flash distillation (MSF), multiple-effect distillation (MED), and vapor compression (VC).

Reverse Osmosis membrane separation:

In which suitable membranes are used for the separation of salts such as the mechanism of reverse osmosis (RO).

Water Capacity m^3/d	Desalination Process	Reactor Type	Plant Name
200	MSF	PWR	Ikata-1,2 (Japan)
454	RO	PHWR	KANUPP (Pakistan)
1000	RO	PWR	Genkai-4 (Japan)
1000	MED	PWR	Genkai-3,4 (Japan)
1000	MED	PWR	Takahama-3,4 (Japan)
1000	MSF	BWR	Kashiwazaki (Japan)
2600	RO	PWR	Ohi-3,4 (Japan)
6300	MSF & MED	PHWR	NDDP(India)
10080			CGN (China)
80000	MSF & MED	LMR	BN-350 (Kazakhstan)

Table [1]: nuclear plants that have been used for desalination of water.

International Atomic Energy Agency (IAEA) role

The IAEA plays vital role in supporting and providing countries with required information to establish non-electric applications. The IAEA nuclear hydrogen production as one of the promising source of energy. Some hydrogen production technologies require heat within (700^o - 1000^o)c which can be produced by nuclear reactors as shown in Fig.[3] nuclear desalination. Furthermore, the IAEA provides the technical help in safety and in assessing the environmental impact of nuclear applications; particularly in nuclear desalination, the IAEA released the Desalination Economic Evaluation Program (DEEP). It is software aims to monitor performance and cost evaluation of nuclear desalination plants through financial economic analysis. It compares different fuels (oil, coal, nuclear) and various desalination options.

Figure [1]: Desalination Economic Evaluation Program (DEEP) released by IAEA.

The International Atomic Energy Agency (IAEA) is developing another software program, Desalination Thermodynamic Optimization Program (DE-TOP), it is designed to provide thermodynamic analysis as well as optimization or cogeneration systems. However, the program is still under development.

The IAEA has released Toolkit to access all publications and activities in nuclear desalination in addition to the available software.

The International Nuclear Desalination Advisory Group (INDAG) on nuclear desalination was formed by IAEA in 1996 with aim to enhance nuclear desalination activities through exchanging the relevant information to promote nuclear desalination operating systems. In 2008 a technical group was formed. This group meets every sixteen to eighteen months at the IAEA headquarters.

District heating of residence and commercial buildings in cold countries

It uses either hot water or steam within the temperature range of (70 - 150) C .

Industrial process heat supply

The nuclear heat produced supplies food processing, paper industry, chemical industry, petroleum and coal processing, and primary metal industries [4]. The heat required for industrial applications are within the range of the heat provided by the current operating reactors as shown in Fig. [2] and Fig. [3].

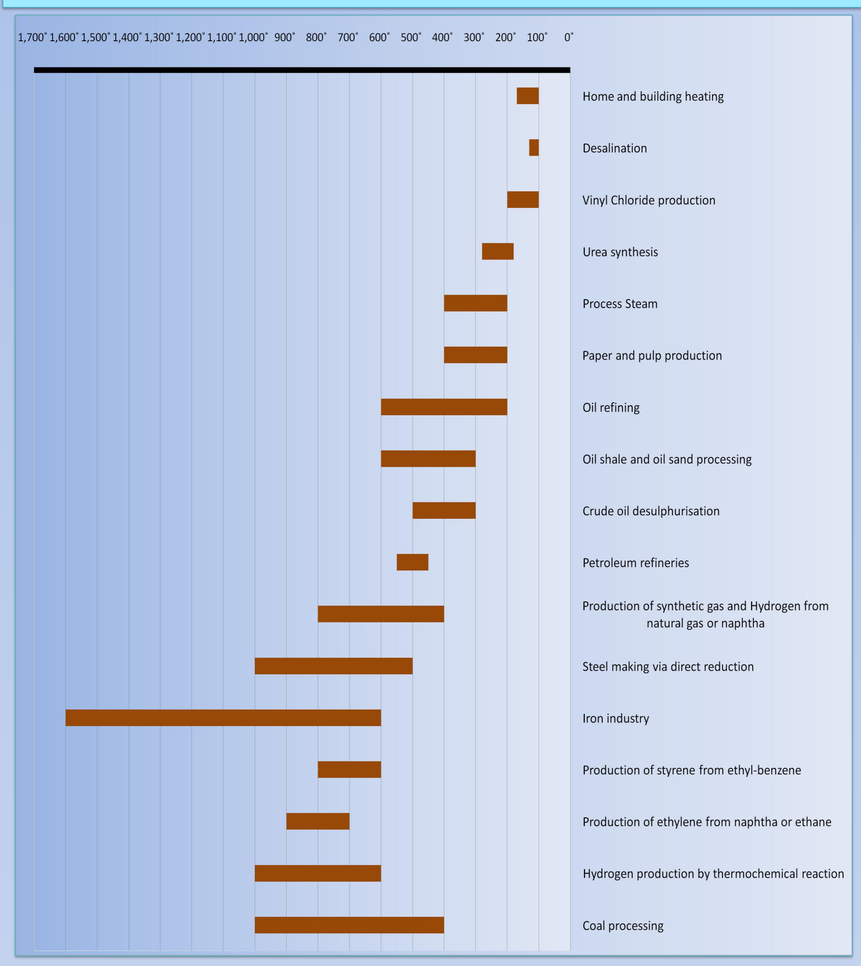

Figure [2]: The heat required for industrial applications .

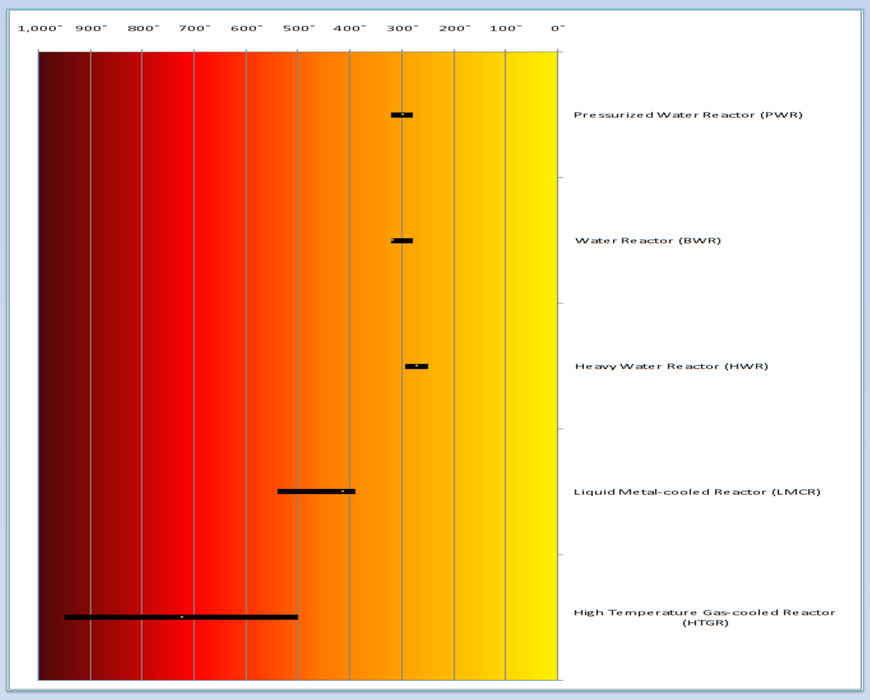

Figure [3]: The heat produced by different reactors types .

Conclusion

Nuclear energy is reliable source of energy and it is environmentally friendly. The cogeneration of heat from the existing used reactors is feasible and would provide energy for wide range of non-electric applications.

References

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