Analysis of Strengths of Korean Vitrification Technology Comparing to UK

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1. Introduction

So far Sellafield Waste Vitrification Plant (WVP) in UK performed a stable and durable waste vitrification progress for long-term storage and subsequent disposal towards high radioactive liquid waste generated from reprocessing of spent fuel. WVP used a two stage design based on the continuous French AVH (Atelier de Vitrification de la Hague) process. Instead Korean vitrification technology developed by KHNP inherently used cold crucible melter with 300 kW high frequency generator (frequency: 300 kHz) and 200 kW plasma torch system for low level and intermediate level waste [1]. This paper shows the strengths of Korean vitrification technology comparing to UK in economic, technical and social point of view because many foreign countries including Japan plans to adopt it due to much merits.

2. Korean Technology Merits

Vitrification technology is focused on high radioactive waste for stabilizing and subsequent safe disposal because of the use of expensive glass, etc. comparing to other waste stabilizing and treatment technologies. The patent information searching service site (KIPRIS) also shows the utilization trend of vitrification technology targeting high radioactive waste [2].

2.1 History of technology development between Korea and UK

The history of UK technology is shown in Table 1.

Table 1. History of UK vitrification technology

Division	year
Research into vitrification started	1950s
Fingal developed by UKAEA laboratories, Harwell Operation(72 glass-making runs)	1960-1962 1962-1966
Review decision to continue for HARVEST process	1972
Detailed comparison of HARVEST And French AVM process Decision of implementation of AVM process	1979-1980 1980
Full scale inactive facility(FSIF) replica of AVM process built Operation	1981-1983 1983-1991
Commission of WVP Operation Line 1,2 and (3)	1989-1990 1990-date (2002-date)
Vitrification Test Rig(VTR) constructed VTR operation	2002-2004 2004-date

UK have accumulated long-term experiences since 1950s. But Korea started the feasibility R&D in 1991 for 5 years, and constructed commercial facility from 2002 till 2006 at Uljin after accomplishing pilot plant R&D and commercial plant design, etc. Especially Korean technology also cooperated with SGN (Areva's subsidiary Company) during pilot plant R&D (1997-1998).

2.2 Description of Vitrification Technology

Fig. 1 shows the UK progress for HLW [3].

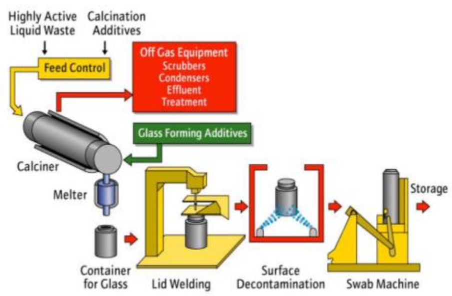

Fig. 1. UK vitrification technology at Shellafield.

High active liquid waste is combined with sugar solution (to reduce ruthenium volatilization and enhance de-nitration) and the produced dry power is heated to ~ 1,050°C at induction-heated melter. The used glass was by UK in itself to maximize the waste incorporation whilst meeting the process requirements (easy of manufacture, melter residence time and viscosity) and having acceptable chemical durability and thermal stability. Finally two mixture windscale (MW) compositions for base glass were selected as shown in Table 2.

Table 2. Composition of base glasses

Base glass type	SiO_2	B_2O_3	Na_2O	Li_2O
MW	61.75	21.88	11.05	5.33
MW-1/2Li	63.42	22.50	11.35	2.74

Instead KHNP targeted vitrification technology development targeting LLW waste in consideration of disposal site aspects. Fig. 2 shows the schematic of Korean vitrification plant installed at Uljin. The main characteristics of the technology are; 1) combined process (induction-heated cold melter and plasma torch melter) is adopted, 2) dust collection, dioxin dissolution device, acid gas removal device and de-NOx device are installed in consideration of environmental problems, 3) vitrification process in which the simultaneous loading of wastes (for example; W1 wastes including DAW, low radioactive spent resin, Zeolite and high temperature filter dust as well as W1 & high radioactive spent resin) applied is possible, and 4) high performance glass is used, etc.

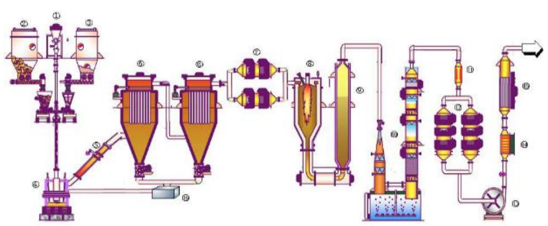

Fig. 2. Vitrification System installed at Uljin NPP.

2.3 Merit of Korean vitrification technology

KHNP's vitrification technology has much merits such as operation easiness, easy adaptability to high radioactive waste with cold crucible melter application and various adaptability towards LLW targeting D&D, especially Fukushima site in Japan and Kori #1, etc. in technical point of view, and also has the environmental and economic excellence because environment-friendly exhaust gas treatment process is equipped, and the construction and maintenance cost are cheap.

3. Conclusion

Korean vitrification technology is compared with UK's in technical, social and economic point of view. As shown in this paper Korean vitrification technology was targeting LLW treatment and stabilization in consideration of Korean disposal site aspect and disposal policy. But it was positively reviewed by foreign countries such as USA, Canada and Japan, etc. to import it because of much merits, and it was also adopted as TCP (technical Cooperation Program) by IAEA. The vitrification technology acceptability can contribute to D&D project towards Kori #1 as well as Fukushima site if the merits of Korean vitrification technology is revealed and noticed around the world as a good choice of stabilizing method for LLW.

REFERENCES

[1] KHNP, "Seminar on performance of vitrification technology development for LLW & MLW (2012).

[2] KIPRIS, "Patent Information Searching Service System" (2018).

[3] Mike T. Harrison, "Vitrification of High Level Waste in the UK", Procedia Materials Science 7 (2014).