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Experiment of Compression Intensity with CWDS Paraffin Encapsulation Wax

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1. Introduction

Liquid Radioactive waste generated in Nuclear Power Plant system is concentrated in Waste Evaporator primary, then solidified with mingled paraffin and dried powder by operating Concentrate Waste Dryer System(CWDS). Structural integrity of solidified drum generated by the system operating is embossed significantly regarding transportation and storage in repository radioactive waste disposal. In about disposal of the radioactive wastes forms, MOST bulletin 2005-18 "ILW and LLW Radioactive Waste delivery regulation" article 12 is referred to structural integrity and safty of mechanical intensity, but detailed value of intensity is not described. Domestic NPP are standardized to use solidified paraffin compression intensity with 60Psi(4.2 ㎏/㎠). Following preference of NRC Generic Letter (01/24/91) - Waste Form Technical Posititon Rev1.

In this experiment, the factors effect on intensity of paraffin encapsulation wax relating with CWDS operating are analyzed and tried to find out the method to prove intensity.

2. Experiment Method and Results

2.1 Conditions and Material

Paraffin used for this experiment is 5 kinds of types (general paraffin wax : SP-0165, SP-0160, LUXCO-160, AZ-300, microcrystalline wax : HIMIC - 1080)
Sample size manufactured following by KS F-2351's standard and cured for seven days.

As Compression intensity tester, we used mechanical digital tester, weight 10tons(capacity), 0.5±0.5% F.S(accuracy), limitation of speed is 2 ~ 100mm/min(loading rate) and it's possible to control.

2.2 Results of compression intensity experiment

2.2.1 Compression intensity of concentrated waste drying powder

Binding force of concentrate waste dryer powder is so weak, so that sample is made after several compaction performances in mold. Compression intensity is, on an average, about 1.02 ㎏/㎠, intensity of dryer powder itself is not meet regulation guide(4.2 ㎏/㎠). This is shown the integrity is maintained after mingling the concentrated waste drying powder and encapsulation wax.

2.2.2 Compression intensity of paraffin

Result of compression intensity which measured using the samples made with pure paraffin showing that HIMIC-1080 got the highest intensity average as 26.3 ㎏/㎠.

(unit : ㎏/㎠)

HIMIC -1080	SP-0165	SP-0160	LUXCO -160	AZ-300
26.3	22.1	21.9	21.6	14.6

Table 1. Pure Paraffin data

If you see deformation of the properties after compression experiment, paraffin wax is splitted in directivity by stress to circle direction, microcrystalline wax is splitted vertically by stress.

Data of crack form and intensity showing that paraffin wax is weak at internal pressure so that the degree of transformation is quiet high and microcrystalline wax got high intensity, but got little embitterment.

2.2.3 Compression intensity measurement by heating

Compared the compression intensity add different proportion of paraffin after concentrated waste dried by heater at the temperature of atmosphere (100℃).

(unit : ㎏/㎠)

Model / add	HIMIC -1080	SP -0165	SP -0160	LUXCO -160	AZ-300
20%	10.0	7.4	8.7	6.7	6.2
25%	36.4	36.1	31.4	29.6	22.9
30%	35.9	27.5	22.0	27.9	21.9

Table 2. Measured data by added proportion of paraffin

HIMIC-1080	SP-0165	SP-0160	LUXCO-160	AZ-300

Fig 1. Picture of each product

In case of added paraffin is 20%, the value of compression intensity is low, so that it means the lack of paraffin addition. The intensity value showed the highest intensity at 25% and it seemed the paraffin surplused at 30%.
When the paraffin adding proportion is insufficient, the intensity reduction is occurred but intensity at 25% got excellent result.

Intensity reduction occurred by lack of paraffin can be prevented by providing 25~30% paraffin considering the error from the calculation weight ratio of concentrate waste dryer sample.

2.2.4 Comparison of specimen compression intensity by CWDS operating

As the results of intensity measurement by heating, compression intensity is measured by application CWDS operating.

Sample size manufactured in ⌀ 5×5 ㎠ and ⌀ 10×10 ㎠, effect of the intensity is analyzed changing variable loading rate of compressor.

sample size	loading rate(mm/min)	intensity(㎏/㎠)
⌀ 5×5 ㎠	5	17.2
	10	20.4
⌀ 10×10 ㎠	5	13.2
	10	15.1

Table 3. Measured data as sample size and loading rate

After mixing the dryer powder made by CWDS operation and HIMIC-1080 at proportion of 25% together, intensity got quiet high result average, 20.4 ㎏/㎠ highly.

We can know that compression intensity is in inverse proportion to sample size and in proportion to loading rate.

2.2.5 Analysis of compression intensity by moisture content

To analyze compression intensity affected by moisture content of CWDS dryer power, measured moisture content following system operating temperature and compression intensity with samples

Temperature	moisture	Intensity(㎏/㎠)
150°F(65℃)	7%	3.8
160°F(71℃)	5%	8.1
170°F(76℃)	3%	10.2
180°F(82℃)	1%	17.2

Note : encapsulation wax(HIMIC-1080), sample size(⌀ 5×5 ㎠), loading rate(5mm/min)

Table 4. Intensity data changed by variable moisture content

Table 4 showing that high intensity is maintained by reducing the moisture content with keep CWDS operating temperature high. The moisture content of dryer power is in inverse proportion to compression intensity.

3. Conclusion

The factors effect on intensity of concentrate waste paraffin encapsulation wax are moisture content in dryer powder, encapsulation class, sample size, variance of loading rate in compression intensity tester.
Sample compression intensity showed high(about 36.4 ㎏/㎠) by heating, but sample intensity by CWDS operating showed lower(17.2 ㎏/㎠) than pure paraffin sample compression intensity(26.3 ㎏/㎠)

Moisture content can be reduced by direct heating temperature (100℃) and CWDS got low intensity because of it's indirect heating operation method by steam so that it maintaining lower drying temperature. Even though, it's showing that the methods of direct heating, is far from perfect dryer. Compression intensity showed lower by residual moisture but it is higher 4 times than NRC regulation guide 60Psi(4.2 ㎏/㎠)

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