A Study on Calculation Program Verification Test Method to Reflect the Lastest Standard of Sample Transfer Rate

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1. Introduction

Radiation monitors of gaseous effluents from nuclear power plants shall meet the design requirements of a sample transport efficiency of at least 50% when applying the ANSI-HPS N13.1 technical standard. In order to enable the design of the sample transport line with the calculation program and the verified correction values without the sample transfer verification test, the method of substituting the transport line verification test method need. During development, test method for the Deposition code(2001), a calculation program, were studied.

2. Test Method

2.1 Test Condition

The sample transfer rate varies depending on the temperature, pressure, flowrate, nozzle specifications, particle dispersion, and other factors. According to design requirements, the test was carried out under the following conditions at 25℃ and 1 atm.

2.1.1 There should be no inward facing step that minimizes the length of the horizontal tube and the number of bends, and reduces the tube diameter by more than 1% at the tube connection.

2.1.2 There should be no burrs or crimping at the end of the transport line.

2.1.3 The curvature ratio of the bend shall not be less 3.0 and not more than 15% flattening.

(flattening = reduced axis/angular midpoint axis)

2.1.4 Criteria for particle sample loss: 50% or more of sample permeability for 10 μm particles

2.1.5 Materials used: To give stainless steel to the nuclear industry

2.1.6 The internal surface smoothness of the transfer line is allowed to be a tube having a ε/d_t of about 5 x 10^5 or less.

(ε=surface roughness, d_t=inside diameter of tube)

2.2 Intuition transport rate test

To apply the test requirements, cut the length of the transfer line from 1m to 12m to verify the sample transport rate in the horizontal tube.

In order to investigate the difference in the transport rate to the tube slope of the transfer line, the sample transfer test is performed by applying the conditions of the tube slope of 30°, 45°, 60°, and 90°. To determine whether there is a difference in the sample transport rate between the up-stream and the down-stream, the transport rate performance test is performed by applying the condition of each tube.

2.3 Curve transport rate test

In ANSI N13.1 (1999), the bending radius is defined as above 3DR, but the sample transfer rate is verified conservatively by applying 5DR.

Deposition 2001a has the same transport rate even under different conditions of tilting of the bend or different direction of suction and discharge. The effect of the transport rate is verified by applying the inclination condition of five curves.

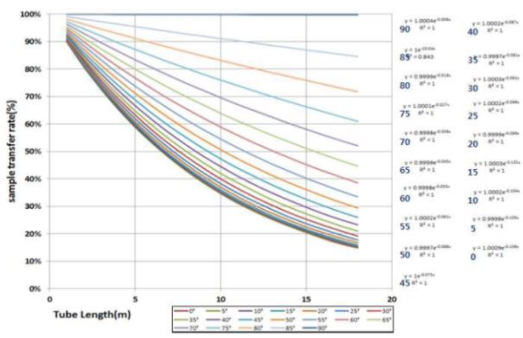

Fig. 1. Calculation results of tube transfer rate.

3. Test Result

The sample transport rate performance test of the transfer tube was performed by measuring five sets of U/S (up-stream) and D/S (down-stream) 10 times each using a particle counter and taking valid data out of the results.

This test was conducted by installing particle generator, particle counter, suction pump, flow regulator, transport line, etc.

Fig. 2. Installation of test equipment.

The sample transport rate was measured by 4m length tube with a diameter of 1-1/ 2" under the condition of 2cfm flowrate. The results of the verification and the sample transport rate of the sample transport rate calculation program were similar. The results of the test are as follows.

Table 1. Test results of tube transfer rate

	U/S	D/S
AVG	92,963	60,012
STD	1,076	2,127
COV	1.,%	3.5%
T/R	64.55%	

	T/R
Verification Test	64.55%
Deposition 2001a	65.50%

SET	#1		#2		#3		#4		#5	
POINT	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S
1	90,069	63,526	93,570	61,441	93,607	61,195	93,492	56,062	93,925	62,137
2	91,742	60,790	92,883	57,713	91,902	60,015	91,615	59,899	93,856	59,503
3	91,844	61,729	94,064	60,296	91,425	59,367	92,789	60,080	94,157	63,986
4	94,574	62,690	92,184	54,468	93,155	60,354	93,044	56,932	93,687	60,598
5	93,816	63,107	92,470	57,249	92,799	57,172	93,407	59,677	95,617	64,425
6	93,352	63,356	91,617	60,356	94,208	62,578	92,776	57,353	92,537	62,332
7	92,576	62,259	92,798	57,571	91,627	60,135	93,700	59,759	93,145	59,484
8	93,420	59,521	90,725	58,748	92,102	61,740	94,584	60,409	92,706	57,551
9	93,187	58,852	93,288	58,853	92,170	59,088	91,744	59,884	93,662	59,573
10	93,656	59,739	91,603	57,732	93,391	58,685	93,350	58,913	94,548	61,740
AVG	92,824	61,557	92,520	58,443	92,639	60,033	93,050	58,897	93,784	61,133
STD	1,303	1,722	1,015	1,982	931	1,570	888	1,538	898	2,179
COV	1.4%	2.8%	1.1%	3.4%	1.0%	2.6%	1.0%	2.6%	1.0%	3.6%
T/R	66.3%		63.2%		64.8%		63.3%		65.2%	

4. Conclusion

If the radiation monitoring system has to be applied to the latest technical standards requirements in accordance with the revision of the technical standards, it is necessary to apply the calculation program and the proven calibration values without the sample transfer verification test. And we have studied the test method for verifying the calculation program.

The preliminary test was performed before the full-scale test, and the test result was similar to the sample transfer efficiency of the calculation program.

In the future, we will develop a methodology for the substitution of the transport line test based on the results of the demonstration test with various locations and bending tests.

REFERENCES

[1] ANSI/HPS N13.1-1999, “Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities”, American National Standards Institute and the Health Physics Society.

[2] 40 CFR 60, Appendix A, Method 1. “Method 1— Sample and Velocity Traverses for Stationary Sources.” Code of Federal Regulations, U.S. Environmental Protection Agency.