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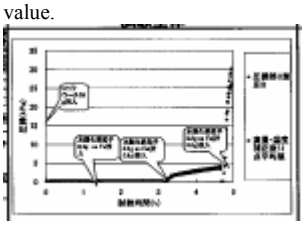
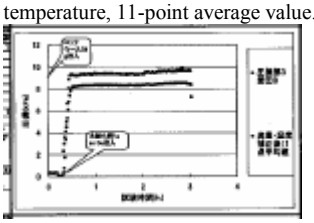
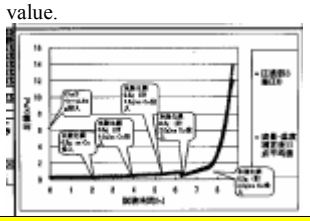
PL#	Test conditions			Complete test
3.22-5	Rock wool (g)		59	[(left) Pressure loss (kPa) (bottom) Test period (h) (first capsule) 59 g of rock wool was introduced (second capsule) 0.4 g of iron hydroxide particles as Fe were introduced. (third capsule) 0.2 g of iron hydroxide particles as Fe were introduced (total 0.6 g) (fourth capsule (0.2 g of iron hydroxide particles as Fe were introduced (total 0.8 g) (right top bullet) Pressure differential B in pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value. 
	Preparation method	Wet pulverization		
	Iron hydroxide (g) as Fe	First	0.4	
		Second	0.2	
		Third	0.2	
		Total	0.8	
	Test method			
	The pressure loss measuring element was built into the device and the rock wool was introduced through the debris inlet. Iron hydroxide was introduced through the debris inlet.			
	Flow velocity cm/s (flow rate L/min) 0.37 (4)			
	Hydrazine/boric acid/NaOH system			
3.22-6-1	Rock wool (g)		59	[(left) Pressure loss (kPa) (bottom) Test period (h) (first capsule) 59 g of rock wool was introduced (second capsule) 1 g of copper hydroxide as Cu was introduced. (right top bullet) Pressure differential B in pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value. 
	Preparation method	Wet pulverization		
	Copper hydroxide (g) as Cu	First	1	
		Total	1	
	Test method			
	The pressure loss measuring element was built into the device and the rock wool was introduced through the debris inlet. Copper hydroxide was introduced through the debris inlet.			
	Flow velocity cm/s (flow rate L/min) 0.37 (4)			
	Hydrazine/boric acid/NaOH system			
3.22-6-2	Rock wool (g)		59	[(left) Pressure loss (kPa) (bottom) Test period (h) (first capsule) 59 g of rock wool was introduced (second capsule) 0.5 g of copper hydroxide as Cu was introduced. (third capsule) 0.5 g of copper hydroxide as Cu was introduced. (total 1.0) (fourth capsule) 0.5 g of copper hydroxide as Cu was introduced. (total 1.5) (fifth capsule) 0.5 g of copper hydroxide as Cu was introduced. (total 2.0) (sixth capsule) 0.5 g of copper hydroxide as Cu was introduced. (total 2.5) (right top bullet) Pressure differential B in pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value. 
	Preparation method	Wet pulverization		
	Copper hydroxide (g) as Cu (red text indicates introduction from tank)	First	0.5	
		Second	0.5	
		Third	0.5	
		Fourth	0.5	
		Fifth	0.5	
		Total	2.5	
	Test method			
	The pressure loss measuring element was built into the device and the rock wool was introduced through the debris inlet. Copper hydroxide was introduced from tank.			
	Flow velocity cm/s (flow rate L/min) 0.37 (4)			
	Hydrazine/boric acid/NaOH system			

Fig. 3.3.7.5 Results of water quality effect test in hydrazine/boric acid/sodium hydroxide system (2/2)

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PL#	Test conditions			Complete test
3.22-7	Rock wool (g)		59	[(left) Pressure loss (kPa) (bottom) Test period (h) (first capsule) 59 g of rock wool was introduced (second capsule) 0.4 g of aluminum hydroxide as Al was introduced. (third capsule) 0.4 g of aluminum hydroxide as Al was introduced (total 0.8 g). (fourth capsule) 0.4 g of aluminum hydroxide as Al was introduced. (total 1.2 g). (fifth capsule) 0.4 g of aluminum hydroxide as Al was introduced (total 1.6 g). (right top bullet) Pressure differential B in pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value.
	Preparation method	Wet pulverization		
	Aluminum hydroxide (g) as Al	First	0.4	
		Second	0.4	
		Third	0.4	
		Fourth	0.4	
		Total	1.6	
	Test method			
	The pressure loss measuring element was built			

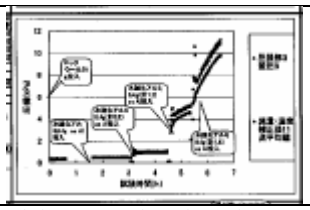
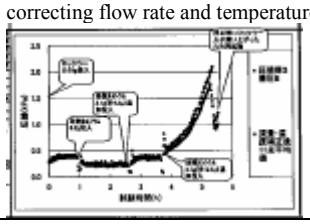
	into the device and the rock wool was introduced through the debris inlet. Aluminum hydroxide was introduced through debris inlet.			
	Flow velocity cm/s (flow rate L/min) 0.37 (4)			
	Hydrazine/boric acid/NaOH system			
3.22-8	Rock wool (g)		59	[(left) Pressure loss (kPa) (bottom) Test period (h) (first capsule) 59 g of rock wool was introduced (second capsule) 6.2 g of calcium silicate was introduced. (third capsule) 3.1 g of calcium silicate was introduced (total 9.3 g). (fourth capsule) 3.1 g of calcium silicate was introduced. (total 12.4 g). (fifth capsule) When operation stopped, the rock wool rose up, causing a second rise. (right top bullet) Pressure differential B in pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value. 
	Preparation method	Wet pulverization		
	Calcium silicate (g)	First	6.2	
		Second	3.1	
		Third	3.1	
		Total	12.4	
	Test method			
	The pressure loss measuring element was built into the device and the rock wool was introduced through the debris inlet. Calcium silicate was introduced through debris inlet.			
	Flow velocity cm/s (flow rate L/min) 0.37 (4)			
	Hydrazine/boric acid/NaOH system			

Fig. 3.3.7.5 Results of water quality effect test in hydrazine/boric acid/sodium hydroxide system (2/2) (cont'd)

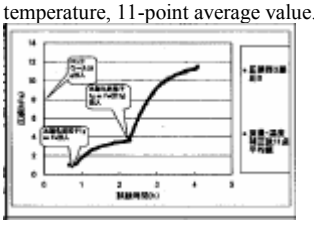
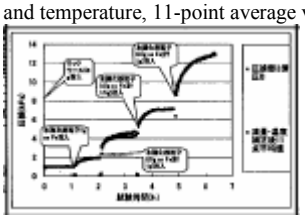
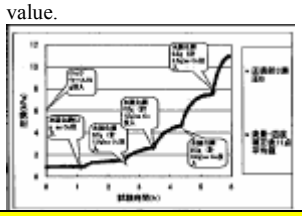
PL#	Test conditions			Complete test
3.23-1-1	Rock wool (g)	59		[(left) Pressure loss (kPa) (bottom) Test period (h) (first capsule) 59 g of rock wool was introduced (second capsule) 1 g of iron hydroxide as Fe was introduced. (third capsule) 1 g of iron hydroxide as Fe was introduced. (total 2 g) (right top bullet) Pressure differential B in pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value. 
	Preparation method	Dry pulverization		
	Iron hydroxide (g) as Fe (red text indicates introduction from tank)	First	1	
		Second	1	
		Total	2	
	Test method			
	The pressure loss measuring element was built into the device and the rock wool was introduced through the debris inlet. Iron hydroxide was introduced from tank.			
	Flow velocity cm/s (flow rate L/min) 2 (21.8)			
	Sodium tetraborate/boric acid system			
3.23-1-2	Rock wool (g)	59		[(left) Pressure loss (kPa) (bottom) Test period (h) (first capsule) 59 g of rock wool was introduced (second capsule) 0.5 g of iron hydroxide as Fe was introduced. (third capsule) 0.5 g of iron hydroxide as Fe was introduced. (total 1 g) (fourth capsule) 0.5 g of iron hydroxide as Fe was introduced (total 1.5 g) (fifth capsule) 0.5 g of iron hydroxide as Fe was introduced (total 2.0 g) (right top bullet) Pressure differential B in pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value. 
	Preparation method	Dry pulverization		
	Iron hydroxide (g) as Fe	First	0.5	
		Second	0.5	
		Third	0.5	
		Fourth	0.5	
		Total	2	
	Test method			
	The pressure loss measuring element was built into the device and the rock wool was introduced through the debris inlet. Iron hydroxide was introduced through the debris inlet.			
	Flow velocity cm/s (flow rate L/min) 2 (21.8)			
	Sodium tetraborate/boric acid system			
3.23-2	Rock wool (g)	59		[(left) Pressure loss (kPa) (bottom) Test period (h) (first capsule) 59 g of rock wool was introduced (second capsule) 0.5 g of copper hydroxide as Cu was introduced. (third capsule) 0.5 g of copper hydroxide as Cu was introduced. (total 1 g) (fourth capsule) 0.5 g of copper hydroxide as Cu was introduced (total 1.5 g) (fifth capsule) 0.5 g of copper hydroxide as Cu was introduced (total 2.0 g) (sixth capsule) 0.5 g of copper as Cu was introduced (total 2.5 g) (right top bullet) Pressure differential B in pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value. 
	Preparation method	Dry pulverization		
	Copper hydroxide (g) as Cu (red text indicates introduction from tank).	First	0.5	
		Second	0.5	
		Third	0.5	
		Fourth	0.5	
		Fifth	0.5	
		Total	2.5	
	Test method			
	The pressure loss measuring element was built into the device and the rock wool was introduced through the debris inlet. Copper hydroxide was introduced from tank.			
	Flow velocity cm/s (flow rate L/min) 2 (21.8)			
	Sodium tetraborate/boric acid system			

Fig. 3.3.7.6 Results of water quality effect test in sodium tetraborate/boric acid system (1/2)

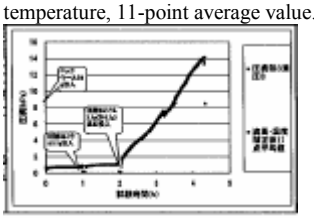
PL#	Test conditions			Complete test
3.23-3	Rock wool (g)		59	Without aluminum hydroxide, the pressure loss increased to about 1.0 kPa. When 0.5 g of aluminum hydroxide was introduced, the pressure loss increased to 2.3 kPa, and when 1.0 g was introduced, to about 3.7 kPa (trend data have not yet been obtained).
	Preparation method	Dry pulverization		
	Aluminum hydroxide (g) as Al.	First	0.5	
		Second	0.5	
		Third	0.5	
		Total	1.5	
	Test method			
	The pressure loss measuring element was built into the device and the rock wool was introduced through the debris inlet. Aluminum hydroxide was introduced through the debris inlet.			
	Flow velocity cm/s (flow rate L/min) 2 (21.8)			
	Sodium tetraborate/boric acid system			
3.23-4	Rock wool (g)		59	[(left) Pressure loss (kPa) (bottom) Test period (h) (first capsule) 59 g of rock wool was introduced (second capsule) 3.1 g of calcium silicate was introduced. (third capsule) 3.1 g of calcium silicate was introduced. (total 6.2 g) (right top bullet) Pressure differential B in pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value. 
	Preparation method	Dry pulverization		
	Calcium silicate (g) .	First	3.1	
		Second	3.1	
		Total	6.2	
	Test method			
	The pressure loss measuring element was built into the device and the rock wool was introduced through the debris inlet. Calcium silicate was introduced through the debris inlet.			
	Flow velocity cm/s (flow rate L/min) 2 (21.8)			
	Sodium tetraborate/boric acid system			

Fig. 3.3.7.6 Results of water quality effect test in sodium tetraborate/boric acid system (1/2) (cont'd)

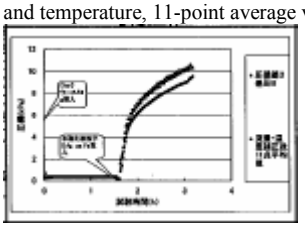
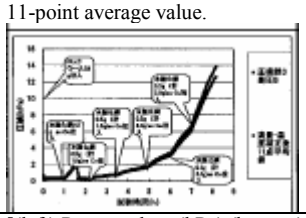
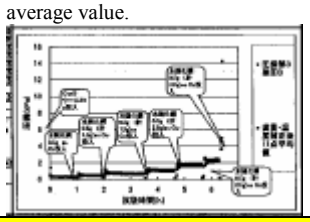
PL#	Test conditions			Complete test
3.23-5	Rock wool (g)	59		[(left) Pressure loss (kPa) (bottom) Test period (h) (first capsule) 59 g of rock wool was introduced (second capsule) 0.4 g of iron hydroxide particles as Fe were introduced. (right top bullet) Pressure differential B in pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value. 
	Preparation method	Wet pulverization		
	Iron hydroxide (g) as Fe.	First	0.4	
		Total	0.4	
	Test method			
	The pressure loss measuring element was built into the device and the rock wool was introduced through the debris inlet. Iron hydroxide were introduced through the debris inlet.			
	Flow velocity cm/s (flow rate L/min) 0.37 (4)			
	Sodium tetraborate/boric acid system			
3.23-6-1	Rock wool (g)	59		[(left) Pressure loss (kPa) (bottom) Test period (h) (first capsule) 59 g of rock wool was introduced (second capsule) 0.5 g of copper hydroxide as Cu was introduced. (third capsule) 0.5 g of copper hydroxide as Cu was introduced (total 1.0 g) (fourth capsule) 0.5 g of copper hydroxide as Cu was introduced (total 1.5 g) (fifth capsule) 0.5 g of copper hydroxide as Cu was introduced (total 2.0 g) (sixth capsule) 0.5 g of copper hydroxide as Cu was introduced (total 2.5 g) (seventh capsule) 0.5 g of copper hydroxide as Cu was introduced (total 3.0 g) (right top bullet) Pressure differential B in pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value. 
	Preparation method	Wet pulverization		
	Copper hydroxide (g) as Cu (red text indicates introduction from tank)	First	0.5	
		Second	0.5	
		Third	0.5	
		Fourth	0.5	
		Fifth	0.5	
		Sixth	0.5	
		Total	3.0	
	Test method			
	The pressure loss measuring element was built into the device and the rock wool was introduced through the debris inlet. Copper hydroxide particles were introduced through the debris inlet.			
	Flow velocity cm/s (flow rate L/min) 0.37 (4)			
	Sodium tetraborate/boric acid system			
3.23-6-2	Rock wool (g)	59		[(left) Pressure loss (kPa) (bottom) Test period (h) (first capsule) 59 g of rock wool was introduced (second capsule) 0.5 g of copper hydroxide as Cu was introduced. (third capsule) 0.5 g of copper hydroxide as Cu was introduced (total 1.0 g) (fourth capsule) 0.5 g of copper hydroxide as Cu was introduced (total 1.5 g) (fifth capsule) 0.5 g of copper hydroxide as Cu was introduced (total 2.0 g) (sixth capsule) 0.5 g of copper hydroxide as Cu was introduced (total 2.5 g) (right top bullet) Pressure differential B in pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value. 
	Preparation method	Wet pulverization		
	Copper hydroxide (g) as Cu (red text indicates introduction from tank)	First	0.5	
		Second	0.5	
		Third	0.5	
		Fourth	0.5	
		Fifth	0.5	
		Total	2.5	
	Test method			
	The pressure loss measuring element was built into the device and the rock wool was introduced through the debris inlet. Copper hydroxide was introduced from tank.			
	Flow velocity cm/s (flow rate L/min) 0.37 (4)			
	Sodium tetraborate/boric acid system			

Fig. 3.3.7.7 Results of water quality effect test in sodium tetraborate/boric acid system (2/2)

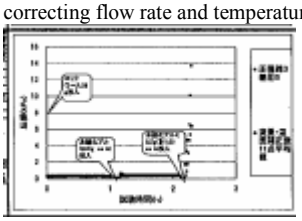
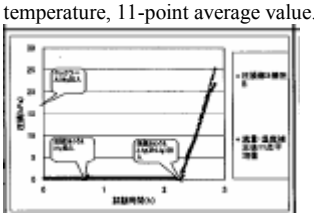
PL#	Test conditions			Complete test
3.23-7	Rock wool (g)		59	[(left) Pressure loss (kPa) (bottom) Test period (h) (first capsule) 59 g of rock wool was introduced (second capsule) 0.5 g of aluminum hydroxide as Al was introduced. (third capsule) 0.5 g of aluminum hydroxide as Al was introduced (total 1.0 g) (right top bullet) Pressure differential B in pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value. 
	Preparation method	Wet pulverization		
	Aluminum hydroxide (g) as Al	First	0.5	
		Second	0.5	
		Total	1	
	Test method			
	The pressure loss measuring element was built into the device and the rock wool was introduced through the debris inlet. Aluminum hydroxide was introduced through the debris inlet.			
	Flow velocity cm/s (flow rate L/min) 0.37 (4)			
	Sodium tetraborate/boric acid system			
3.23-8	Rock wool (g)		59	[(left) Pressure loss (kPa) (bottom) Test period (h) (first capsule) 59 g of rock wool was introduced (second capsule) 3.1 g of calcium silicate was introduced. (third capsule) 3.1 g of calcium silicate was introduced (total 6.2 g) (right top bullet) Pressure differential B in pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value. 
	Preparation method	Wet pulverization		
	Calcium silicate (g)	First	3.1	
		Second	3.1	
		Total	6.2	
	Test method			
	The pressure loss measuring element was built into the device and the rock wool was introduced through the debris inlet. Calcium silicate was introduced through the debris inlet.			
	Flow velocity cm/s (flow rate L/min) 0.37 (4)			
	Sodium tetraborate/boric acid system			

Fig. 3.3.7.7 Results of water quality effect test in sodium tetraborate/boric acid system (2/2) (cont'd)

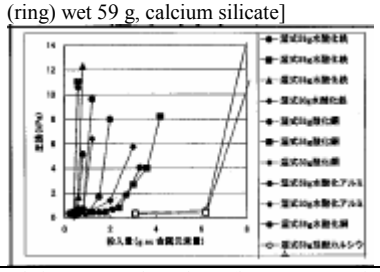
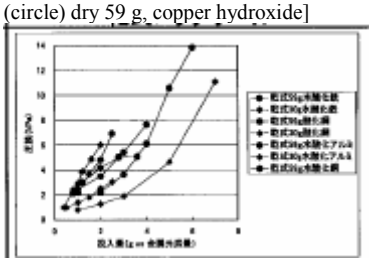
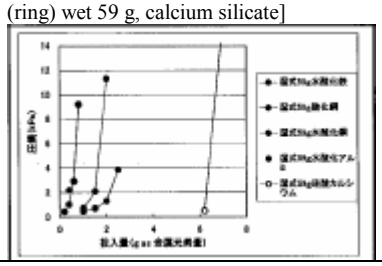
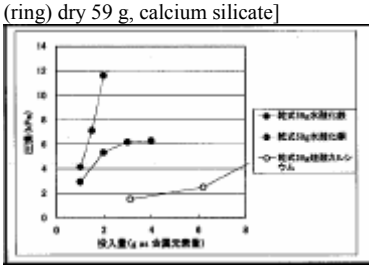
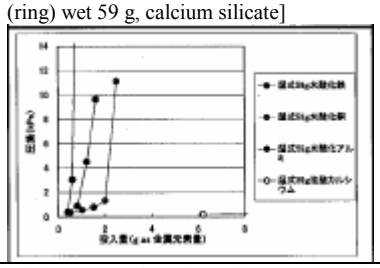
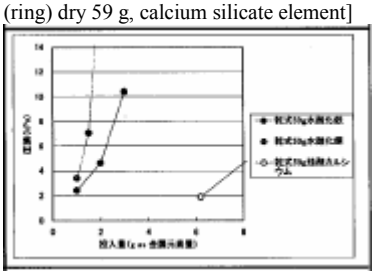
	Wet rock wool	Dry rock wool
Pure water	[(left) Pressure loss (kPa) (bottom) Quantity introduced (in g as quantity of metal element) (circle) wet 59 g, iron hydroxide (square) wet 59 g, iron hydroxide (triangle) wet 59 g, iron hydroxide (diamond) wet 30 g, iron hydroxide (circle) wet 59 g, copper oxide (square) wet 59 g, copper oxide (diamond) wet 30 g, copper oxide (circle) wet 59 g, aluminum hydroxide (diamond) wet 30 g, aluminum hydroxide (circle) wet 59 g, copper hydroxide (ring) wet 59 g, calcium silicate] 	[(left) Pressure loss (kPa) (bottom) Quantity introduced (in g as quantity of metal element) (circle) dry 59 g, iron hydroxide (diamond) dry 30 g, iron hydroxide (circle) dry 59 g, copper oxide (diamond) dry 30 g, copper oxide (circle) dry 59 g, aluminum hydroxide (diamond) dry 30 g, aluminum hydroxide (circle) dry 59 g, copper hydroxide] 
Boric acid	[(left) Pressure loss (kPa) (bottom) Quantity introduced (in g as quantity of metal element) (circle) wet 59 g, iron hydroxide (circle) wet 59 g, copper oxide (circle) wet 59 g, copper hydroxide (circle) wet 59 g, aluminum hydroxide (ring) wet 59 g, calcium silicate] 	[(left) Pressure loss (kPa) (bottom) Quantity introduced (in g as quantity of metal element) (circle) dry 59 g, iron hydroxide (circle) dry 59 g, copper hydroxide (ring) dry 59 g, calcium silicate] 
Hydrazine	[(left) Pressure loss (kPa) (bottom) Quantity introduced (in g as quantity of metal element) (circle) wet 59 g, iron hydroxide (circle) wet 59 g, copper hydroxide (circle) wet 59 g, aluminum hydroxide (ring) wet 59 g, calcium silicate] 	[(left) Pressure loss (kPa) (bottom) Quantity introduced (in g as quantity of metal (circle) dry 59 g, iron hydroxide (circle) dry 59 g, copper hydroxide (ring) dry 59 g, calcium silicate element] 
Sodium tetraborate	[(left) Pressure loss (kPa) (bottom) Quantity introduced (in g as quantity of metal element) (circle) wet 59 g, iron hydroxide (circle) wet 59 g, copper hydroxide (circle) wet 59 g, aluminum hydroxide (ring) wet 59 g, calcium silicate]	[(left) Pressure loss (kPa) (bottom) Quantity introduced (in g as quantity of metal element) (circle) dry 59 g, iron hydroxide (circle) dry 59 g, copper hydroxide (circle) dry 59 g, aluminum hydroxide (ring) dry 59 g, calcium silicate element]

Fig. 3.3.7.8 Combined results of water quality effect tests

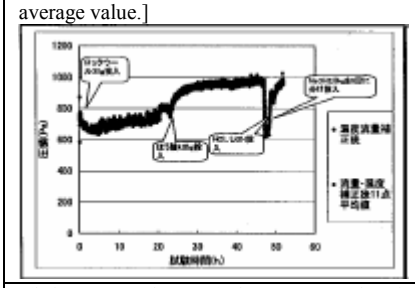
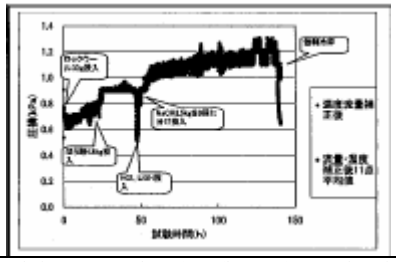
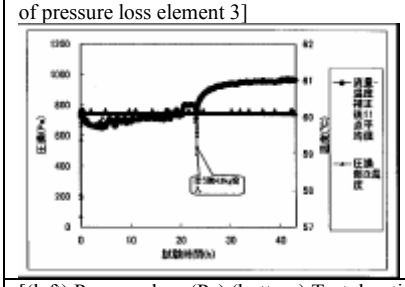
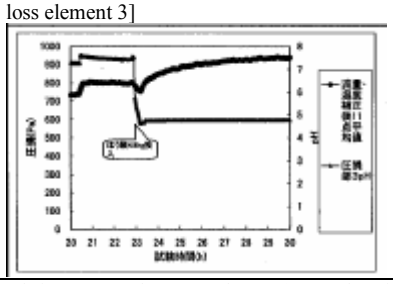
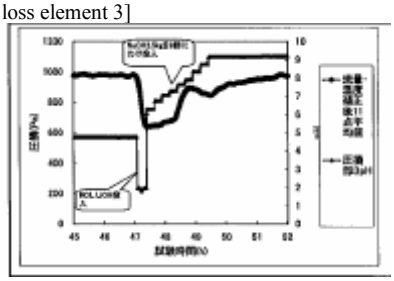
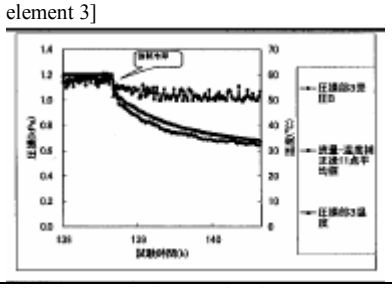
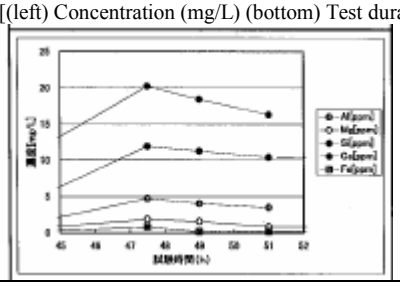
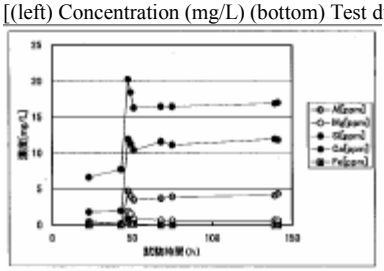
[(left) Pressure loss (Pa) (bottom) Test duration (h) (first capsule) 30 g of rock wool introduced (second capsule) 4.8 kg of boric acid introduced (third capsule) HCl, LiOH introduced (fourth capsule) 2.5 kg of NaOH introduced in 9 increments (right top bullet) After correcting temperature and flow rate (right bot bullet) After correcting flow rate and temperature, 11-point average value.] 	[(left) Pressure loss (kPa) (bottom) Test duration (h) (first capsule) 30 g of rock wool introduced (second capsule) 4.8 kg of boric acid introduced (third capsule) HCl, LiOH introduced (fourth capsule) 2.5 kg of NaOH introduced in 9 increments (fifth capsule) forced cooling (right top bullet) After correcting temperature and flow rate (right bot bullet) After correcting flow rate and temperature, 11-point average value.] 
[(left) Pressure loss (Pa) (bottom) Test duration (h) (capsule) 4.8 kg of boric acid introduced (top dot) After correcting flow rate and temperature, 11-point average value. (bot dot) Temperature of pressure loss element 3] 	[(left) Pressure loss (Pa) (bottom) Test duration (h) (capsule) 4.8 kg of boric acid introduced (top dot) After correcting flow rate and temperature, 11-point average value. (bot dot) pH of pressure loss element 3] 
[(left) Pressure loss (Pa) (bottom) Test duration (h) (first capsule) HCl, LiOH introduced (second capsule) 2.5 kg of NaOH introduced in 9 increments(top dot) After correcting flow rate and temperature, 11-point average value. (bot dot) pH of pressure loss element 3] 	[(left) Pressure loss (Pa) (bottom) Test duration (h) (first capsule) Forced cooling (top dot) Pressure differential B of pressure loss element 3 (mid dot) After correcting flow rate and temperature, 11-point average value. (bot dot) Temperature of pressure loss element 3] 
[(left) Concentration (mg/L) (bottom) Test duration (h) 	[(left) Concentration (mg/L) (bottom) Test duration (h) 

Fig. 3.3.8.1 ICAN#1 reproduction test results (PL#4.1.1 without cooling or reheating)

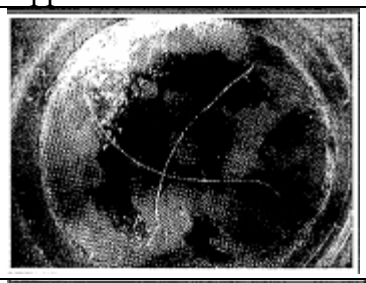
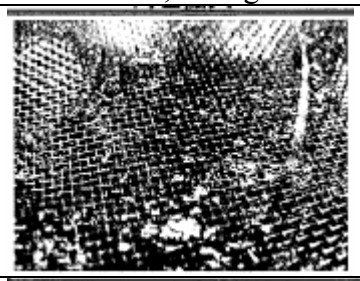
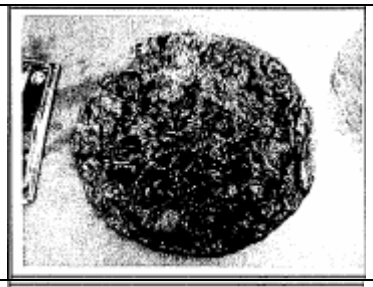
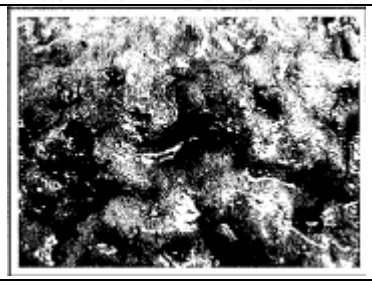
	Appearance of rock wool	Same as left, enlarged
Upstream side (with mesh in place)		
Upstream side		
Downstream side		

Fig. 3.3.8.2 Rock wool following ICAN#1 reproduction test (PL#4.1.1 without cooling and reheating)

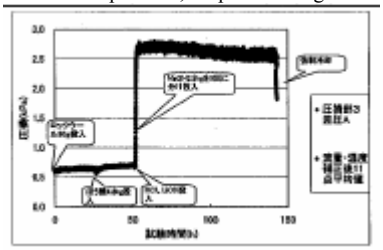
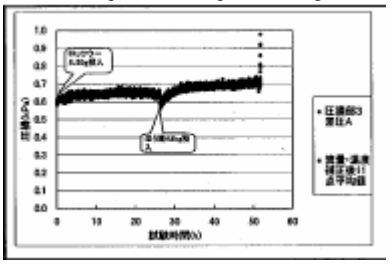
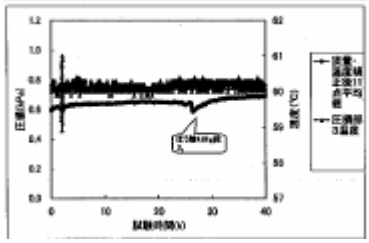
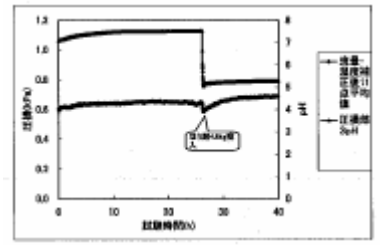
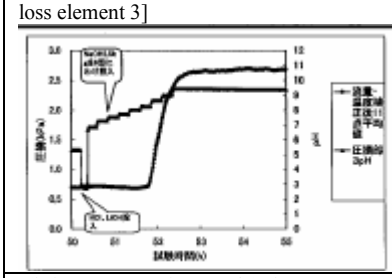
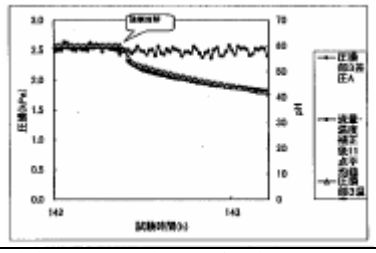
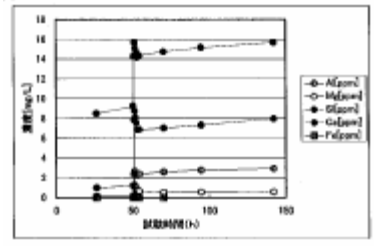
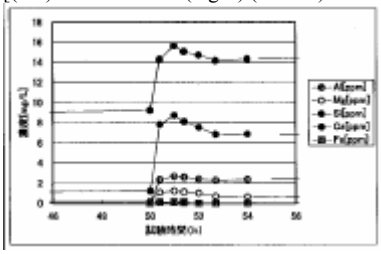
[(left) Pressure loss (kPa) (bottom) Test duration (h) (first capsule) 30 g of rock wool introduced (second capsule) 4.8 kg of boric acid introduced (third capsule) HCl, LiOH introduced (fourth capsule) 2.5 kg of NaOH introduced in 9 increments (fifth capsule) forced cooling (right top bullet) Pressure differential A in pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value.] 	[(left) Pressure loss (kPa) (bottom) Test duration (h) (first capsule) 30 g of rock wool introduced (second capsule) 4.8 kg of boric acid introduced (top bullet) Pressure differential A in pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value.] 
[(left) Pressure loss (kPa) (bottom) Test duration (h) (capsule) 4.8 kg of boric acid introduced (top dot) After correcting flow rate and temperature, 11-point average value. (bot dot) Temperature of pressure loss element 3] 	[(left) Pressure loss (kPa) (bottom) Test duration (h) (capsule) 4.8 kg of boric acid introduced (top dot) After correcting flow rate and temperature, 11-point average value. (bot dot) pH of pressure loss element 3] 
[(left) Pressure loss (kPa) (bottom) Test duration (h) (first capsule) HCl, LiOH introduced (second capsule) 2.5 kg of NaOH introduced in 9 increments (top dot) After correcting flow rate and temperature, 11-point average value. (bot dot) pH of pressure loss element 3] 	[(left) Pressure loss (kPa) (bottom) Test duration (h) (first capsule) Forced cooling (top dot) Pressure differential A of pressure loss element 3 (mid dot) After correcting flow rate and temperature, 11-point average value. (bot dot) Temperature of pressure loss element 3] 
[(left) Concentration (mg/L) (bottom) Test duration (h) 	[(left) Concentration (mg/L) (bottom) Test duration (h) 

Fig. 3.3.8.3 ICAN#1 reproduction rest results (PL#4.1.2 Without cooling and reheating)

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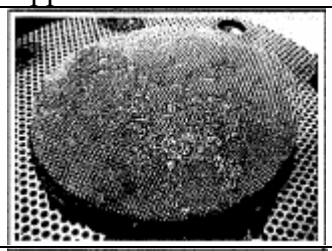
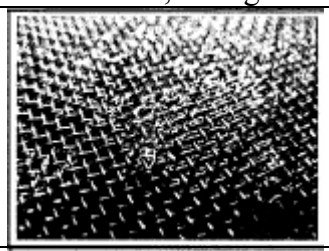
	Appearance of rock wool	Same as left, enlarged
Upstream side (with mesh in place)		
Upstream side		
Downstream side		

Fig. 3.3.8.4 Rock wool following ICAN#1 reproduction test (PL#4.1.2 without cooling and reheating)

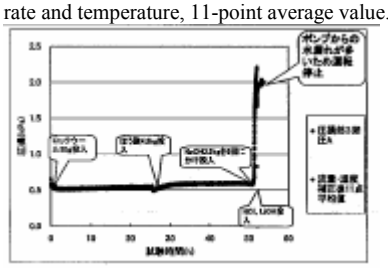
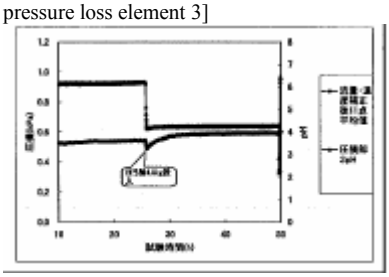
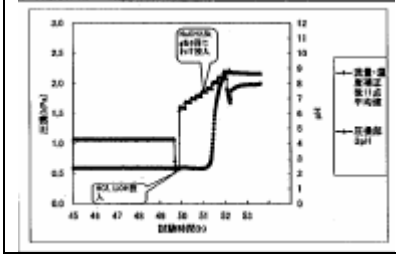
[(left) Pressure loss (kPa) (bottom) Test duration (h) (first capsule) 30 g of rock wool introduced (second capsule) 4.8 kg of boric acid introduced (third capsule) 2.5 kg of NaOH introduced in 9 increments (fourth capsule) HCl, LiOH introduced (fifth capsule) Operation halted because of major water leakage by pump (right top bullet) Pressure differential A in pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value.] 	[(left) Pressure loss (kPa) (bottom) Test duration (h) (capsule) 4.8 kg of boric acid introduced (top dot) After correcting flow rate and temperature, 11-point average value. (bot dot) pH of pressure loss element 3] 
[(left) Pressure loss (kPa) (bottom) Test duration (h) (first capsule) HCl, LiOH introduced (second capsule) 2.5 kg NaOH introduced in 9 increments (top dot) After correcting flow rate and temperature, 11-point average value. (bot dot) pH of pressure loss element 3] 	

Fig. 3.3.8.5 ICAN#1 reproduction test results (PL#4.1.3 Without cooling and reheating)

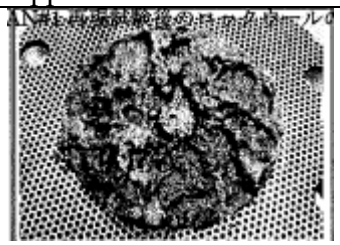
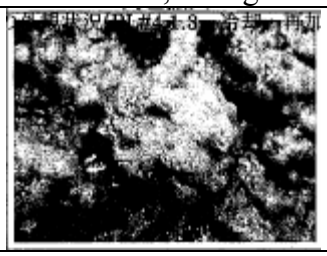
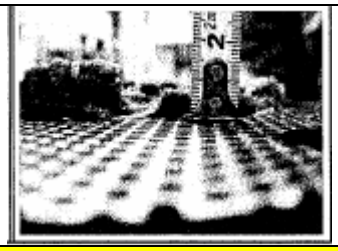
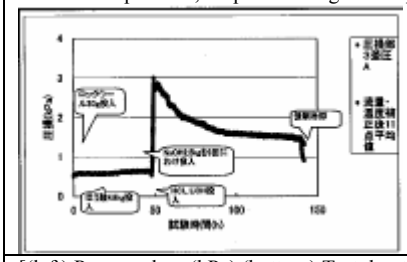
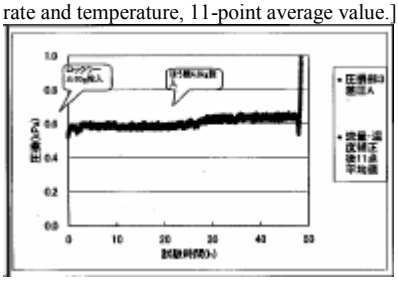
	Appearance of rock wool	Same as left, enlarged.
Upstream side		
Lateral surface view		

Fig. 3.3.8.6 Appearance of rock wool following ICAN#1 reproduction test (PL#4.1.3 without cooling and reheating)

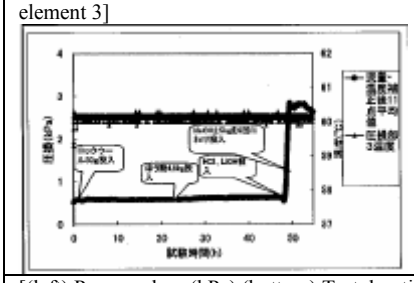
[(left) Pressure loss (kPa) (bottom) Test duration (h) (first capsule) 30 g of rock wool introduced (second capsule) 4.8 kg of boric acid introduced (third capsule) 2.5 kg NaOH introduced in 9 increments (fourth capsule) HCl, LiOH introduced (fifth capsule) Forced cooling (right top bullet) Pressure differential A in pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value.]



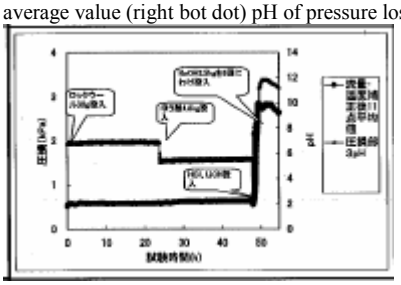
[(left) Pressure loss (kPa) (bottom) Test duration (h) (first capsule) 30 g of rock wool introduced (second capsule) 4.8 kg of boric acid introduced (right top bullet) Pressure differential A in pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value.]



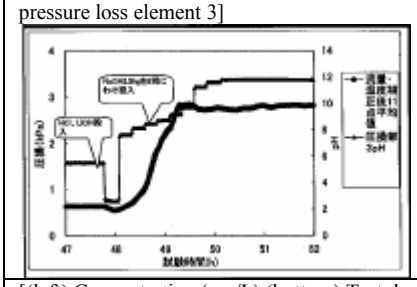
[(left) Pressure loss (kPa) (bottom) Test duration (h) (first capsule) 30 g of rock wool introduced (second capsule) 4.8 kg of boric acid introduced (third capsule) HCl, LiOH introduced (fourth capsule) 2.5 kg NaOH introduced in 9 increments (right top dot) After correcting flow rate and temperature, 11-point average value (right bot dot) Temperature of pressure loss element 3]



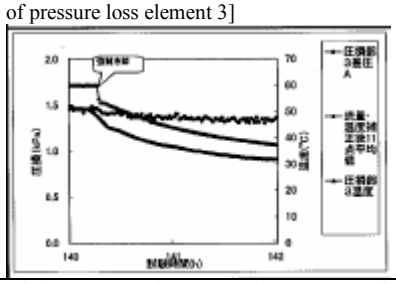
[(left) Pressure loss (kPa) (bottom) Test duration (h) (first capsule) 30 g of rock wool introduced (second capsule) 4.8 kg of boric acid introduced (third capsule) HCl, LiOH introduced (fourth capsule) 2.5 kg NaOH introduced in 9 increments (right top dot) After correcting flow rate and temperature, 11-point average value (right bot dot) pH of pressure loss element 3]



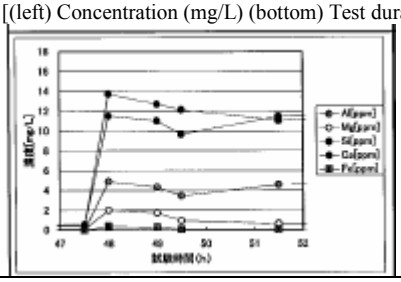
[(left) Pressure loss (kPa) (bottom) Test duration (h) (first capsule) HCl, LiOH introduced (second capsule) 2.5 kg NaOH introduced in 9 increments (right top dot) After correcting flow rate and temperature, 11-point average value (right bot dot) pH of pressure loss element 3]



[(left) Pressure loss (kPa) (bottom) Test duration (h) (caption) Forced cooling (right top dot) Pressure differential A of pressure loss element 3 (right mid dot) After correcting flow rate and temperature, 11-point average value (right bot dot) Temperature of pressure loss element 3]



[(left) Concentration (mg/L) (bottom) Test duration (h)



[(left) Concentration (mg/L) (bottom) Test duration (h)

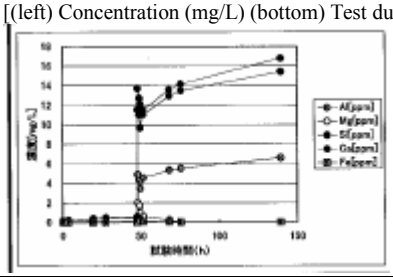


Fig. 3.3.8.7 ICAN#3 reproduction test results (PL#4.2.1 With cooling and reheating)

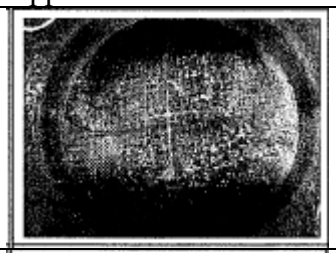
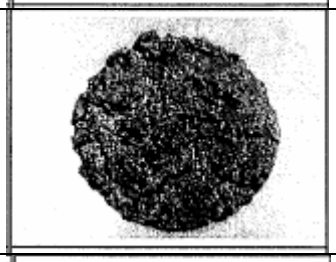
	Appearance of rock wool
Upstream side (with mesh in place)	
Upstream side	
Downstream side	

Fig. 3.3.8.8 Rock wool after ICAN#3 reproduction test (PL#4.2.1 With cooling and reheating)

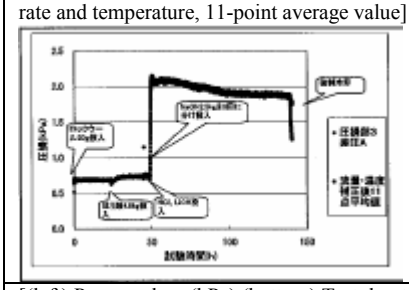
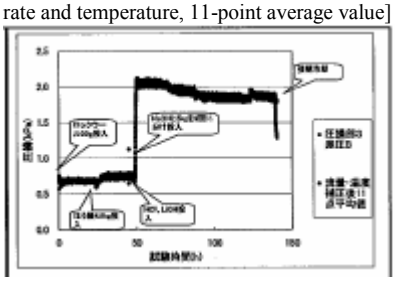
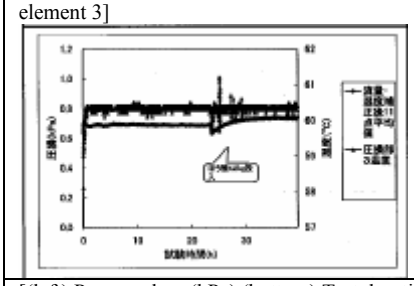
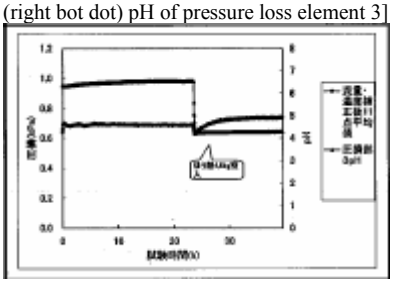
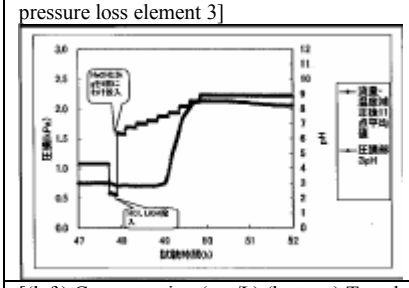
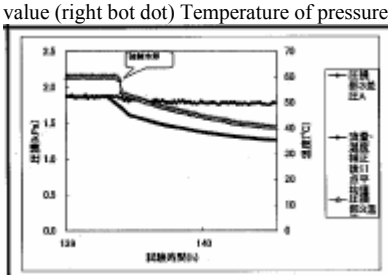
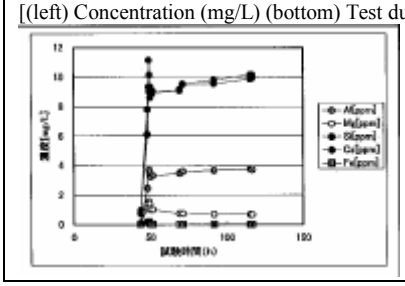
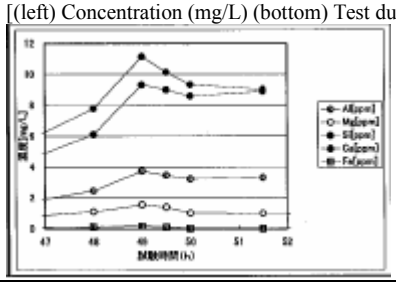
[(left) Pressure loss (kPa) (bottom) Test duration (h) (first capsule) 30 g of rock wool introduced (second capsule) 4.8 kg of boric acid introduced (third capsule) HCl, LiOH introduced (fourth capsule) 2.5 kg NaOH introduced in 9 increments (fifth capsule) Forced cooling (right top bullet) Pressure differential A of pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value] 	[(left) Pressure loss (kPa) (bottom) Test duration (h) (first capsule) 30 g of rock wool introduced (second capsule) 4.8 kg of boric acid introduced (third capsule) HCl, LiOH introduced (fourth capsule) 2.5 kg NaOH introduced in 9 increments (fifth capsule) Forced cooling (right top bullet) Pressure differential B of pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value] 
[(left) Pressure loss (kPa) (bottom) Test duration (h) (right) Temperature (ºC) (first capsule) 4.8 kg of boric acid introduced (right top dot) After correcting flow rate and temperature, 11-point average value (right bot dot) Temperature of pressure loss element 3] 	[(left) Pressure loss (kPa) (bottom) Test duration (h) (first capsule) 4.8 kg of boric acid introduced (right top dot) After correcting flow rate and temperature, 11-point average value (right bot dot) pH of pressure loss element 3] 
[(left) Pressure loss (kPa) (bottom) Test duration (h) (first capsule) HCl, LiOH introduced (second capsule) 2.5 kg NaOH introduced in 9 increments (right top dot) After correcting flow rate and temperature, 11-point average value (right bot dot) pH of pressure loss element 3] 	[(left) Pressure loss (kPa) (bottom) Test duration (h) (right) Temperature (ºC) (first capsule) Forced cooling (right top dot) Pressure differential A of pressure loss element 3 (right mid dot) After correcting flow rate and temperature, 11-point average value (right bot dot) Temperature of pressure loss element 3] 
[(left) Concentration (mg/L) (bottom) Test duration (h) 	[(left) Concentration (mg/L) (bottom) Test duration (h) 

Fig. 3.3.8.9 ICAN#1 reproduction test results (PL#4.2.2 with cooling and reheating)

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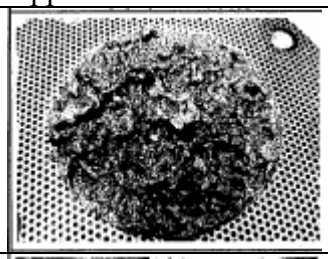
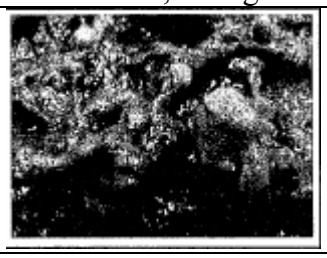
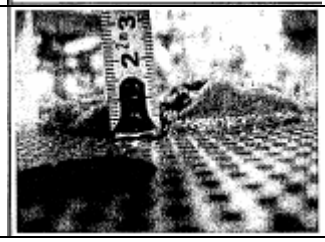
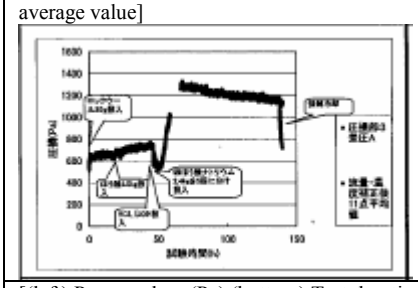
	Appearance of rock wool	Same as left, enlarged
Upstream side		
Lateral surface view		

Fig. 3.3.8.10 Rock wool following ICAN#3 reproduction test (PL#4.2.2 With cooling and reheating)

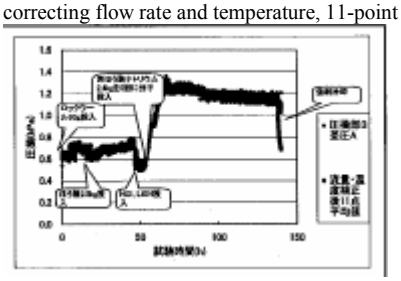
Table 3.3.8.1 Combined ICAN#1 and #3 reproduction test results

		ICAN#1 reproduction			ICAN#3 reproduction	
		4.1.1	4.1.2	4.1.3	4.2.1	4.2.2
With pure water	Beginning	0.73	0.60	0.59	0.52	0.64
	End	0.80	0.65	0.55	0.60	0.69
	Difference	0.07	0.05	- 0.04	0.08	0.05
When boric acid was introduced	Beginning	0.76	0.59	0.50	0.58	0.62
	End	0.99	0.70	0.60	0.64	0.75
	Difference	0.23	0.11	0.10	0.06	0.13
When hydrochloric acid was introduced	Beginning	0.99	0.70	0.60	0.64	0.75
	End	0.64	0.70	0.60	0.55	0.70
	Difference	- 0.35	0.00	0.00	- 0.09	- 0.05
When sodium hydroxide was introduced	Beginning	0.64	0.70	0.60	0.55	0.70
	End	1.13	2.70	2.16	2.85	2.15
	Difference	0.49	2.00	1.56	2.30	1.45

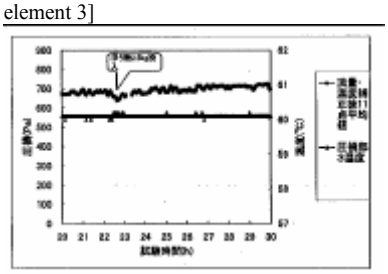
[(left) Pressure loss (Pa) (bottom) Test duration (h) (first capsule) 30 g of rock wool introduced (second capsule) 2.5 kg of boric acid introduced (third capsule) HCl, LiOH introduced (fourth capsule) 2.4 kg of sodium tetraborate introduced in five increments (fifth capsule) Forced cooling (right top bullet) Pressure differential A of pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value]



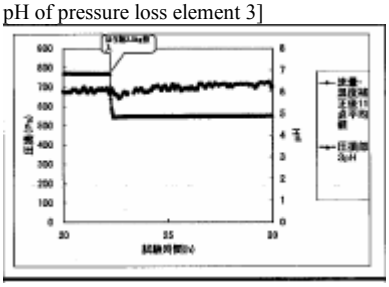
[(left) Pressure loss (Pa) (bottom) Test duration (h) (first capsule) 30 g of rock wool introduced (second capsule) 2.5 kg of boric acid introduced (third capsule) HCl, LiOH introduced (fourth capsule) 2.4 kg of sodium tetraborate introduced in 5 increments (fifth capsule) Forced cooling (right top bullet) Pressure differential A of pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value]



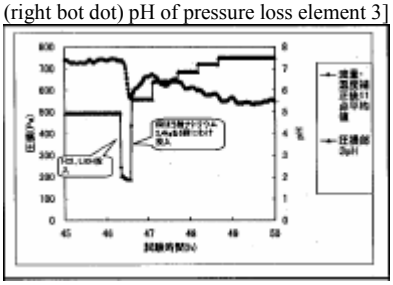
[(left) Pressure loss (Pa) (bottom) Test duration (h) (right) Temperature (ºC) (first capsule) 2.5 kg of boric acid introduced (right top dot) After correcting flow rate and temperature, 11-point average value (right bot dot) Temperature of pressure loss element 3]



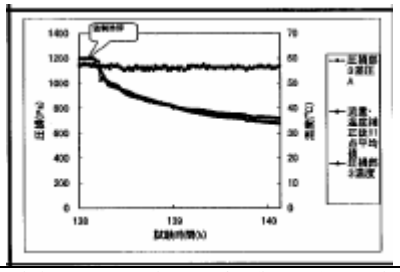
[(left) Pressure loss (Pa) (bottom) Test duration (h) (first capsule) 2.5 kg of boric acid introduced (right top dot) After correcting flow rate and temperature, 11-point average value (right bot dot) pH of pressure loss element 3]



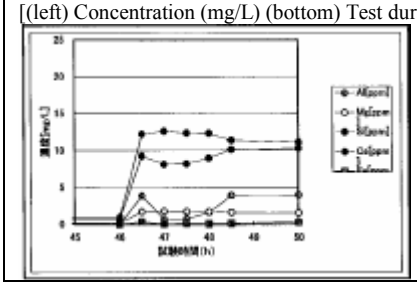
[(left) Pressure loss (Pa) (bottom) Test duration (h) (first capsule) HCl, LiOH introduced (second capsule) 2.4 kg of sodium tetraborate introduced in five increments (right top dot) After correcting flow rate and temperature, 11-point average value (right bot dot) pH of pressure loss element 3]



[(left) Pressure loss (Pa) (bottom) Test duration (h) (right) Temperature (ºC) (first capsule) Forced cooling (right top dot) Pressure differential A of pressure loss element 3 (right mid dot) After correcting flow rate and temperature, 11-point average value (right bot dot) Temperature of pressure loss element 3]



[(left) Concentration (mg/L) (bottom) Test duration (h)



[(left) Concentration (mg/L) (bottom) Test duration (h)

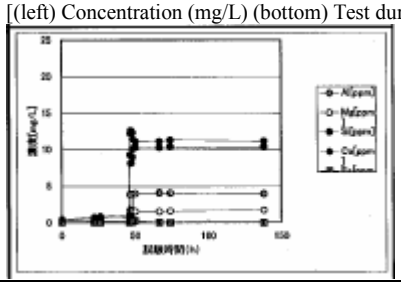


Fig. 3.3.9.1 ICAN#4 preliminary test results (PL#5.1 Sodium tetraborate/boric acid system)

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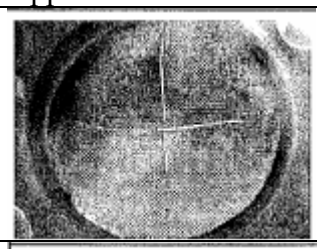
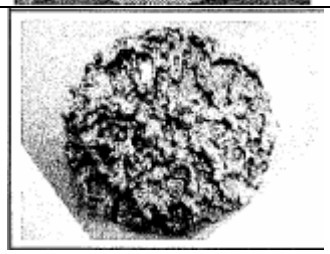
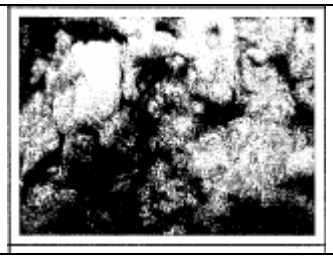
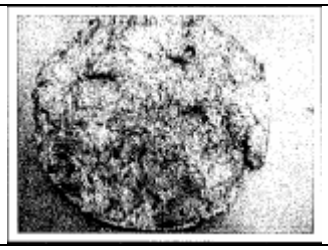
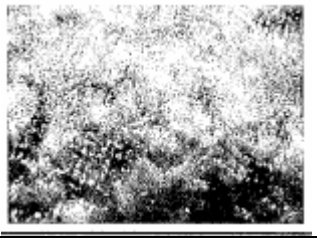
	Appearance of rock wool	Same as left, enlarged
Upstream side (with mesh in place)		
Upstream side		
Downstream side		

Fig. 3.3.9.2 Appearance of rock wool after ICAN#4 preliminary test (PL#5.1 Sodium tetraborate/boric acid system)

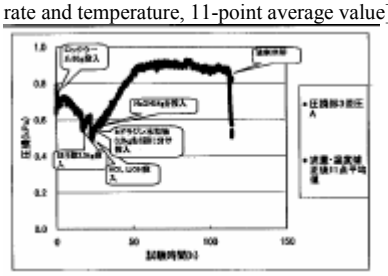
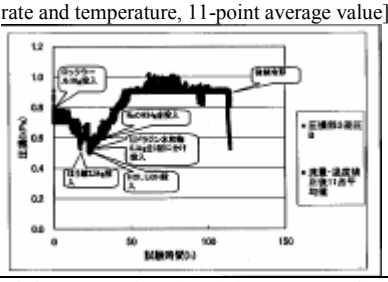
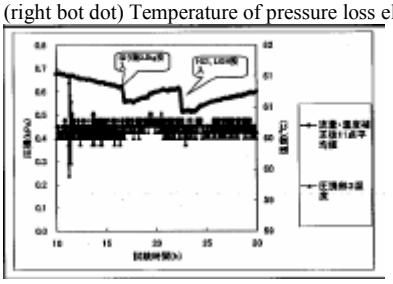
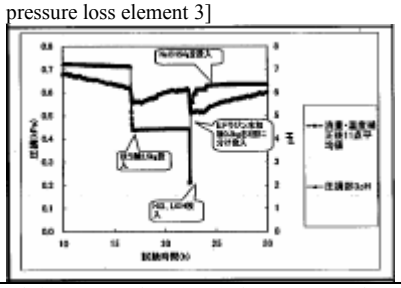
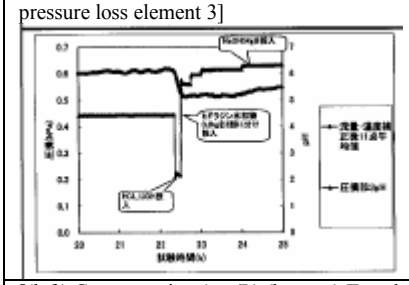
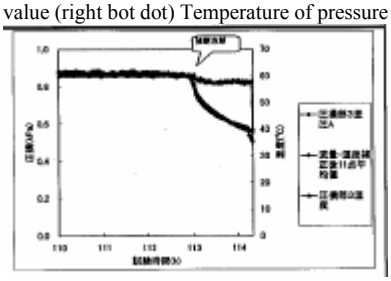
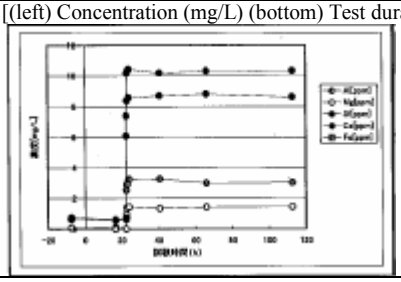
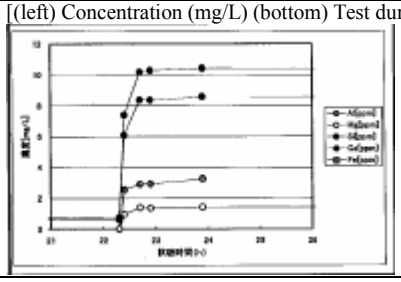
[(left) Pressure loss (KPa) (bottom) Test duration (h) (first capsule) 30 g of rock wool introduced (second capsule) 2.5 kg of boric acid introduced (third capsule) HCl, LiOH introduced (fourth capsule) 0.3 kg of hydrazine hydrate introduced in three increments (fifth capsule) 54 g of NaOH introduced (sixth capsule) Forced cooling (right top bullet) Pressure differential A of pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value] 	[(left) Pressure loss (KPa) (bottom) Test duration (h) (first capsule) 30 g of rock wool introduced (second capsule) 2.5 kg of boric acid introduced (third capsule) HCl, LiOH introduced (fourth capsule) 0.3 kg of hydrazine hydrate introduced in three increments (fifth capsule) 54 g of NaOH introduced (sixth capsule) Forced cooling (right top bullet) Pressure differential B of pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value] 
[(left) Pressure loss (KPa) (bottom) Test duration (h) (right) Temperature (ºC) (first capsule) 2.5 kg of boric acid introduced (second capsule) HCl, LiOH introduced (right top dot) After correcting flow rate and temperature, 11-point average value (right bot dot) Temperature of pressure loss element 3] 	[(left) Pressure loss (KPa) (bottom) Test duration (h) (first capsule) 2.5 kg of boric acid introduced (second capsule) HCl, LiOH introduced (third capsule) 0.3 kg of hydrazine hydrate introduced in three increments (fourth capsule) 54 g of NaOH introduced (right top dot) After correcting flow rate and temperature, 11-point average value (right bot dot) pH of pressure loss element 3] 
[(left) Pressure loss (KPa) (bottom) Test duration (h) (first capsule) HCl, LiOH introduced (second capsule) 0.3 kg of hydrazine hydrate introduced in three increments (third capsule) 54 g of NaOH introduced (right top dot) After correcting flow rate and temperature, 11-point average value (right bot dot) pH of pressure loss element 3] 	[(left) Pressure loss (KPa) (bottom) Test duration (h) (right) Temperature (ºC) (capsule) Forced cooling (right top dot) Pressure differential A of pressure loss element 3 (right mid dot) After correcting flow rate and temperature, 11-point average value (right bot dot) Temperature of pressure loss element 3] 
[(left) Concentration (mg/L) (bottom) Test duration (h) 	[(left) Concentration (mg/L) (bottom) Test duration (h) 

Fig. 3.3.9.3 ICAN#5 preliminary test results (PL#5.2 Hydrazine/boric acid/sodium hydroxide system)

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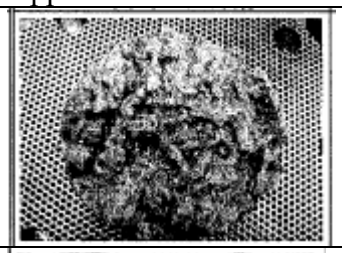
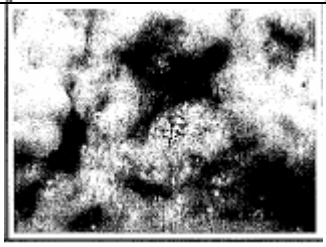
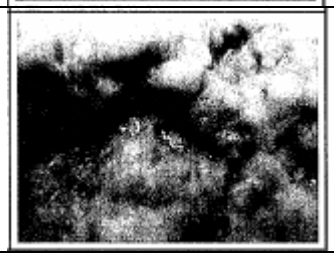
	Appearance of rock wool	Same as left, enlarged
Upstream side		
Peculiar portion		

Fig. 3.3.9.4 Appearance of rock wool after ICAN#5 preliminary test (PL#5.2 Sodium tetraborate/boric acid system)

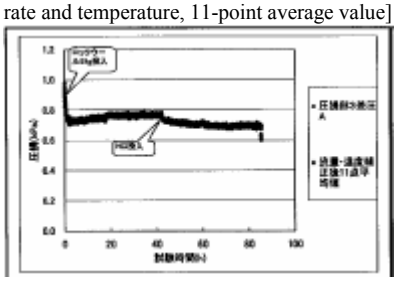
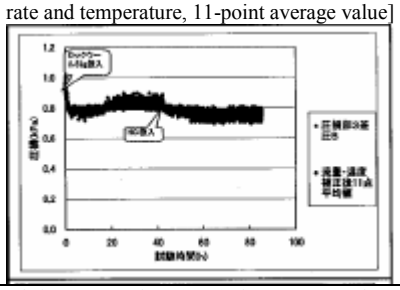
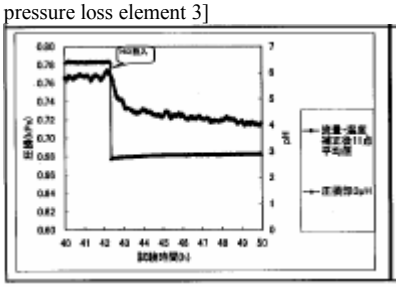
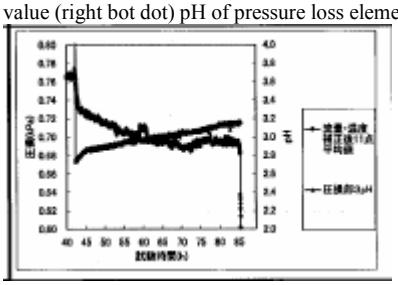
[(left) Pressure loss (KPa) (bottom) Test duration (h) (first capsule) Introduction of 59 g of rock wool (second capsules) Introduction of HCl (right top bullet) Pressure differential A of pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value] 	[(left) Pressure loss (KPa) (bottom) Test duration (h) (first capsule) Introduction of 59 g of rock wool (second capsules) Introduction of HCl (right top bullet) Pressure differential B of pressure loss element 3 (right bot bullet) After correcting flow rate and temperature, 11-point average value] 
[(left) Pressure loss (KPa) (bottom) Test duration (h) (first capsule) Introduction of HCl (right top dot) After correcting flow rate and temperature, 11-point average value (right bot dot) pH of pressure loss element 3] 	[(left) Pressure loss (KPa) (bottom) Test duration (h) (right top dot) After correcting flow rate and temperature, 11-point average value (right bot dot) pH of pressure loss element 3] 

Fig. 3.3.9.5 ICAN#6 preliminary test results (PL#5.3 Pure water (BWR) system)

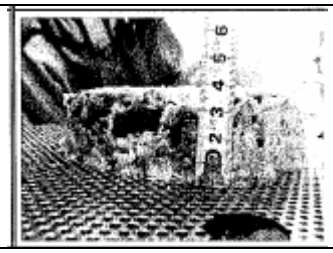
	Appearance of rock wool	Same as left, enlarged
Upstream side		
Peculiar portion		

Fig. 3.3.9.6 Appearance of rock wool after ICAN#6 preliminary test (PL#5.3 Pure water (BWR) system)

4. Integrated Chemical Effect Assessment Tests

4.1. Objectives

To examine the chemical effects exerted by pressure loss under conditions approximating those of an actual plant, integrated chemical effect assessment on NPSH (ICAN) is conducted using chemical effect assessment loops. In fiscal 2005, the chemical effects on pressure loss when only rock wool was present as an insulating material were examined (ICAN-1). In fiscal 2006, testing of conditions under which both rock wool and calcium silicate were present (ICAN-2) and of simulated conditions under which heating and cooling by an excess heat removal system (ICAN-3) was conducted. In fiscal 2007, testing was conducted under ice condenser-type plant conditions (ICAN-4), plant conditions employing hydrazine as a pH buffer (ICAN-5), BWR conditions (ICAN-6), dry condenser plant conditions to determine the test results of ICAN-1 (ICAN-7), and hydrazine spray conditions to examine the effects on adjustment of simulated debris (ICAN-8).

4.2. Methods

A prescribed chemical was dissolved in test water heated to 60ºC. Insulating materials and simulated structural materials such as metal coupons, concrete, and paint materials were placed in liquid phase and gas phase portions. Following placement of the insulating materials and simulated structural materials, spraying was begun. The start of spraying was denoted as hour 0. The test water was adjusted to 1,000 L in all, including the quantity that was added during spraying. The quantities of insulating material and simulated structural material were determined[(4)] by comparison of the ratios of insulating materials and structural materials in actual plant sump water and with reference to U.S. test examples[(1)].

4.2.1 ICAN-4

In ice condenser-type plants, sodium tetraborate ($Na_2B_4O_7$) is employed as a pH-regulating agent. Table 4.1 shows chemicals that were dissolved in the test tank in ICAN-4. Tables 4.2 and 4.3 show the insulating materials and structural materials that were placed in the liquid phase portions and gas phase portions, respectively. Table 4.4 shows the simulated debris that was placed in pressure loss measuring elements 1 and 2. Fig.

4.5 shows the recirculation flow rate, spray flow rate, and flow rates of pressure loss measuring elements 1 and 2. Boric acid (H_3BO_3) was dissolved in 1,000 L of test water prior to placement of the insulating materials and simulated structural materials, and hydrochloric acid (HCl) was added just before the start of spraying. The total quantity of sodium tetraborate was divided into six parts. Addition to the tank was begun simultaneously with the start of spraying, with an additional part being added every 15 minutes thereafter and the entire quantity having been dissolved after 75 minutes. Spraying was conducted for 4 hours.

Table 4.1 Chemicals dissolved in the test tank in ICAN-4. The hydrochloric acid concentration was 35 percent.

H_3BO_3	$Na_2B_4O_7 \cdot 10H_2O$	NaOH	$LiOH \cdot H_2O$	HCl
8176 g	7784 g	0 g	2.4 g	286 g

Table 4.2 Insulating materials and structural materials placed in the liquid phase portion in ICAN-4.

Insulating materials			Metals			Concrete	Paint
Calcium silicate	Rock wool	Glass wool	Aluminum	Copper	Carbon steel		Carbozinc 11
0	9680 g	0	13 x 13 mm	0 sheet	7 sheets	0 sheet	1 sheet
	(0.121 m^3)						

Table 4.3 Insulating materials and structural materials placed in the gas phase portion in ICAN-4.

Insulating materials			Metals			Concrete	Paint
Calcium silicate	Rock wool	Glass wool	Aluminum	Copper	Carbon steel		Carbozinc 11
0	1280 g	0	56 x 56 mm	0 sheet	126 sheets	0 sheet	0 sheet
	(0.016 m^3)						

Table 4.4 Quantities of simulated debris of insulating materials in pressure loss measuring elements 1 and 2 in ICAN 4

Pressure loss measuring element 1

Calcium silicate	Rock wool	Glass wool
0 g	30 g	0

Pressure loss measuring element 2

Calcium silicate	Rock wool	Glass wool
0 g	13.4 g	0