● *High Corrosion Control Technology*

FUJI FLAKE LINING SYSTEMS

FUJI RESIN

A Global Line-up of Advanced Anti-corrosion Systems

FUJI FLAKE LINING SYSTEMS

In 1967, Fuji Resin became the first company in Japan to develop a unique anti-corrosion lining—Fuji Flake. This lining is being put to effective use in flue gas desulfurization plants in the areas of power generation, iron and steel, non-ferrous metals, pulp and papermaking, chemical processing and garbage incineration. It is also enjoying considerable sales in many industrial fields as it stands up magnificently to severe conditions of corrosive gases and chemicals, heat and abrasion.
In other applications, too, it has earned great acclaim as a high-technology product exhibiting ideal corrosion preventing functions which replace rubber linings and anti-corrosive metals.
We at Fuji Resin are applying our extensive experience in researching, developing and producing the most effective of materials. To achieve this, we have established a high-grade and thorough system of high-quality corrosion control design, safety control and site work management. And now we can respond with comprehensive anti-corrosion systems through the most advanced maintenance technology for life research, modification, renovation and upgrade technology.
Our sphere of operations now includes U.S.A., Germany, U.K., Italy, S.Korea, Taiwan and S.E. Asia. Thanks to our technology exports, local technical guidance and technological tie-ups, our corrosion control systems are being given a great deal of worldwide attention.

CONTENTS

A Wide Range of Programs for Tackling an Extensive Range of Applications

Fuji Flake lining is a result of proprietary Fuji Resin technology. It is made by compositing 2 to 5 μm thick, 0.2 to 3 mm large flake glass with thermosetting resins such as vinyl ester, polyester and epoxy. This is then coated or lined to a thickness of 0.2 to 4 mm. Other related systems have also been used Chemeq-Line or Fuji Brick for added functionality such as high corrosion preventing and heat resistance, and extended to field applications. Consequently, we have completed a wide range of corrosion control systems that meet an extensive range of applications.

HIGH CORROSION CONTROL PROGRAMS

Fuji Flake Lining Systems

Standard type

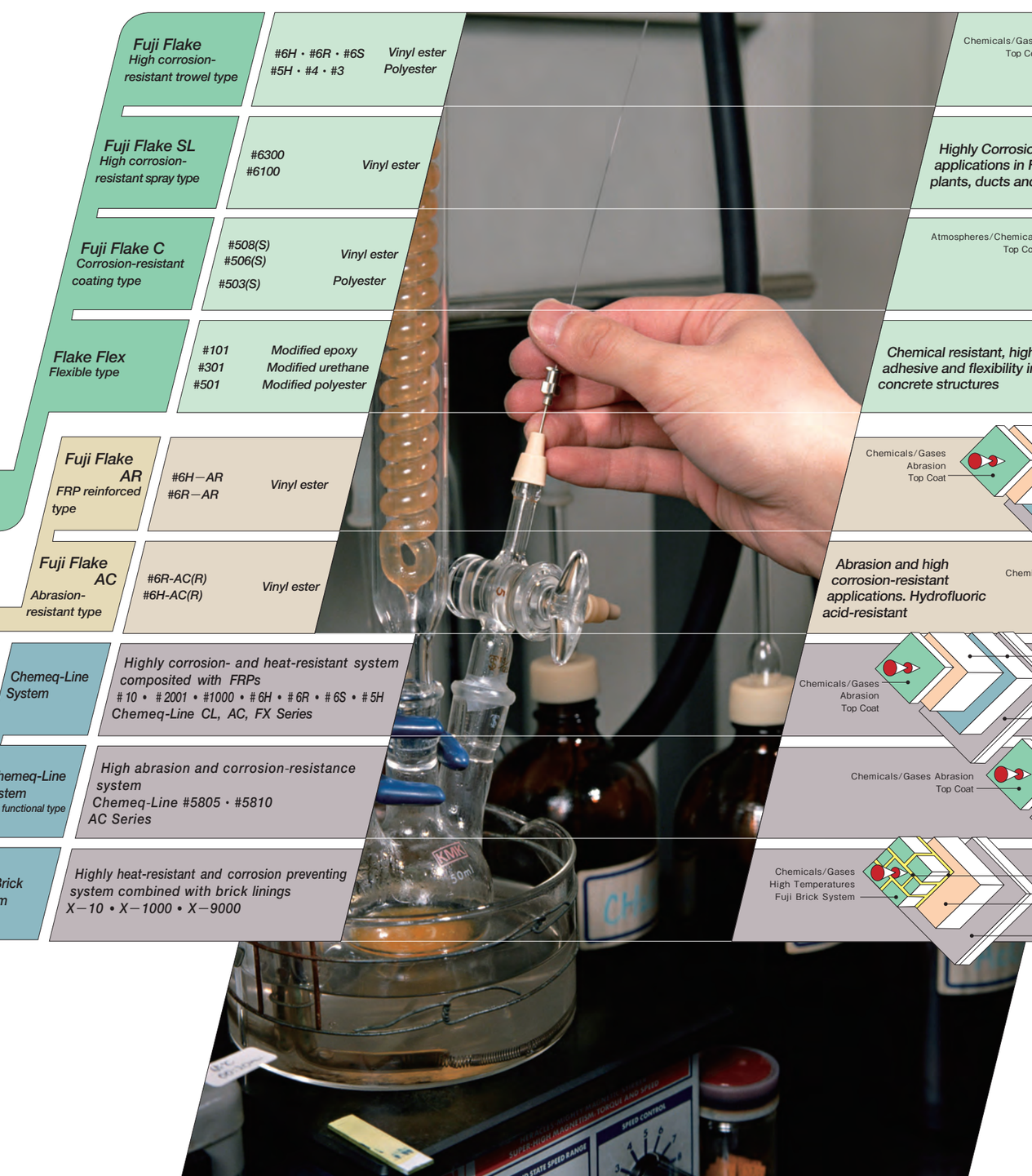
- **Fuji Flake** — High corrosion-resistant trowel type
  - #6H・#6R・#6S / #5H・#4・#3 — Vinyl ester / Polyester
  - Chemicals/Gases, Top Coat, Fuji Flake, Primer
  - *Highly corrosion-resistant applications in DeSOx, DeNOx plants, ducts and stacks chemical processing equipment, etc.*
- **Fuji Flake SL** — High corrosion-resistant spray type
  - #6300, #6100 — Vinyl ester
  - Chemicals/Gases, Top Coat, Fuji Flake SL, Primer
  - *Highly Corrosion-resistant applications in FGD plants, ducts and stacks*
- **Fuji Flake C** — Corrosion-resistant coating type
  - #508(S), #506(S), #503(S) — Vinyl ester / Polyester
  - Atmospheres/Chemicals, Top Coat, Fuji Flake C, Primer
  - *High-Class paint applications in ships, bridges, marine structures, chemical plants etc.*
- **Flake Flex** — Flexible type
  - #101, #301, #501 — Modified epoxy / Modified urethane / Modified polyester
  - Chemicals/Gases, Top Coat, Flake Flex, Primer
  - *Chemical resistant, high adhesive and flexibility in concrete structures*

Functional type

- **Fuji Flake AR** — FRP reinforced type
  - #6H—AR, #6R—AR — Vinyl ester
  - Chemicals/Gases, Abrasion, Top Coat, Fuji Flake AR, Primer
  - *Highly Corrosion and heat resistant applications. Attachments corner reinforced*
- **Fuji Flake AC** — Abrasion-resistant type
  - #6R-AC(R), #6H-AC(R) — Vinyl ester
  - Chemicals/Gases, Abrasion, Top Coat, Fuji Flake AC, Primer
  - *Abrasion and high corrosion-resistant applications. Hydrofluoric acid-resistant*

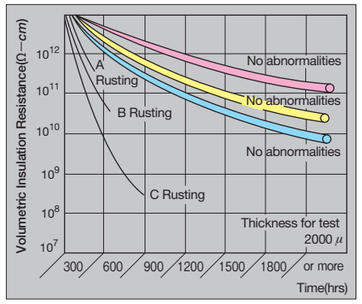
Related systems

- **Chemeq-Line System**
  - *Highly corrosion- and heat-resistant system composited with FRPs*
  - *#10 • #2001 • #1000 • #6H • #6R • #6S • #5H*
  - *Chemeq-Line CL, AC, FX Series*
  - Chemicals/Gases, Abrasion, Top Coat, Chemeq-Line System, Primer
  - *Applications requiring high corrosion-resistance and heat-resistance in chemical processing equipment, etc.*
- **Chemeq-Line System** — High functional type
  - *High abrasion and corrosion-resistance system*
  - *Chemeq-Line #5805 • #5810*
  - *AC Series*
  - Chemicals/Gases, Abrasion, Top Coat, Chemeq-Line System (High functional type), Primer
  - *Applications requiring high abrasion-resistant, Hydrofluoric acid-resistant*
- **Fuji Brick System**
  - *Highly heat-resistant and corrosion preventing system combined with brick linings*
  - *X—10 • X—1000 • X—9000*
  - Chemicals/Gases, High Temperatures, Fuji Brick System, Fuji Mastic, Fuji Flake System, Primer
  - *Applications requiring high heat-resistance in incinerated garbage gases, high temperature liquids in chemical processing, etc.*



Fuji Flake forms a multi-layer barrier that is stable for long periods in corrosive environments and performs outstandingly. This barrier completely protects the structure and forms horizontal lines in the matrix to prevent the permeation of gases such as water vapor, oxygen or corrosive gases—all causes of corrosion—and forms a solid bond with the material of the structure.

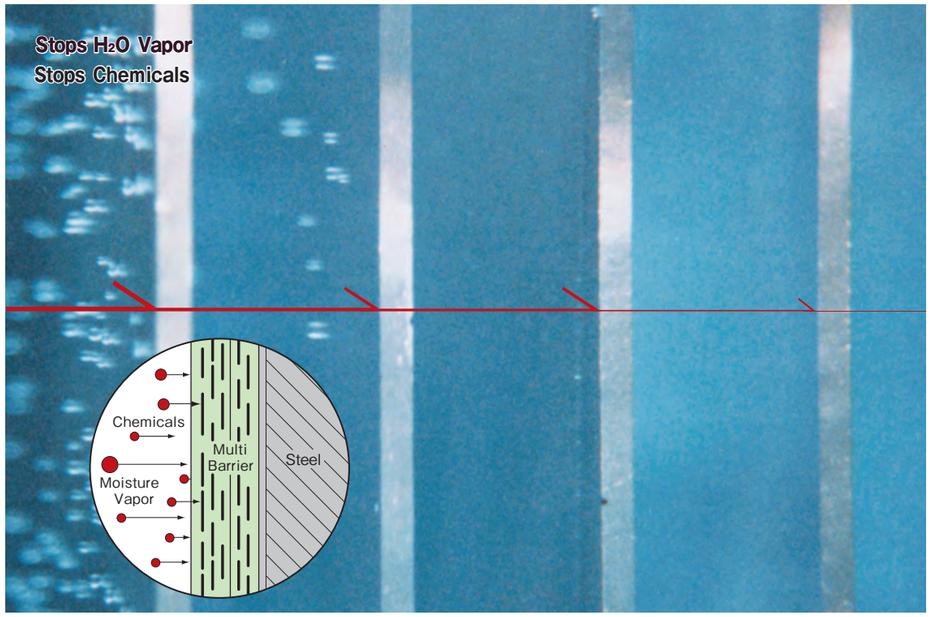
• Promotion Test of Anti-water vapor permeability (In-house comparison values)

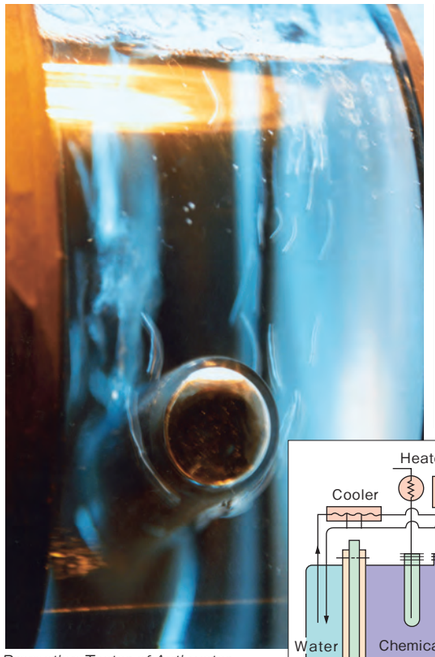


Fuji Flake SL#6300
Fuji Flake #6H-AR
Fuji Flake #6H

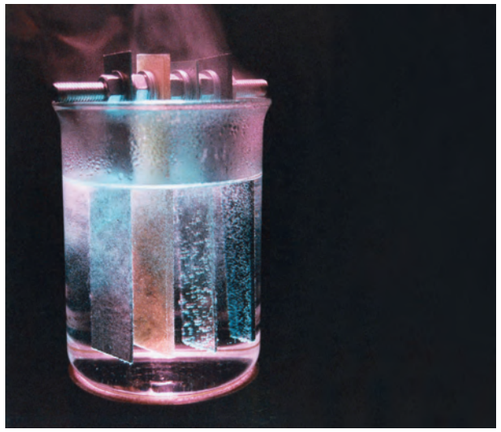
A General FRP lining B General Flake lining (small size)
C General Flake lining (large size)

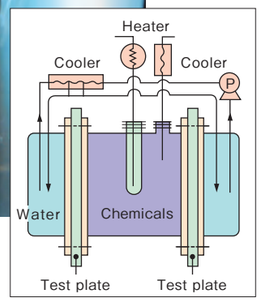
Proprietary Fuji Resin technology has increased the anti-water vapor permeability of Fuji Flake and Fuji Flake SL. Thanks to longer-lasting corrosion resistance, we have achieved a long last of results in flue gas desulfurization plants. In chemical processing, complex reactions and synthesis are combined and a high level of chemical resistance is required. Fuji Resin responds to this field with Fuji Flake-AR and further with Chemeq-Line system, a composite FRP technology. Also, the high-temperature region can be extended up to 800°C by using it in combination with the Fuji Brick system, as this supports chemical resistance at high temperatures.





Promotion Tester of Anti-water vapor permeability





Deterioration of flake glass affected by fluoric acid — microphotograph

Service Life Prolonged by a Stable Multi-Layer Barrier

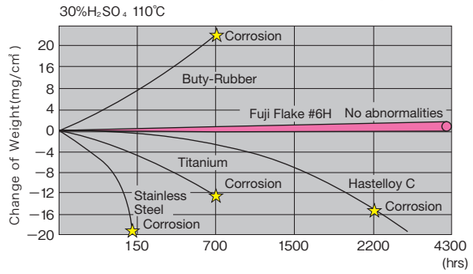
Anti-water Vapor Permeability and Chemical Resistance

• Chemical Resistance of Fuji Flake

			30℃			60℃			90℃			120℃			150℃			180℃
Inorganic Acids	Sulfuric Acid	25%										6H	10	10	10	10		
		50%						6H	6H	6H	6H	10	10	10	10	10		
		70%						6S	6S	10	10	10	10					
		80%					6S	10	10									
	Hydrochloric Acid	10%						6H	6H	6H	10	10	10					
		25%					6H	6H	6H	10	10	10						
		37%	6R	6R	6R	6H	6H	6H	10	10	10	10	10					
	Nitric Acid	10%						5H	5H	5H								
		20%					5H	5H	5H	5H								
	Phosphoric Acid	50%										6H	10	10	10	10		
		85%						10	10	10	10	10	10	10	10			
	Chromic Acid	5%	5H	5H	5H	5H	5H	5H										
		20%	5H	5H	5H	5H	5H	5H										
	Hydrofluoric Acid *	5%	6R	6R	6R	6R	6R	6R	6R	6R	6H	10						
		20%	6R	6R	6R	6R	6R	6R	6H	10	10							
Organic Acids	Acetic-Acid	10%							6H	6H	6H	10	10	10				
		50%						6H	6H	10	10	10	10	10				
		75%					10	10	10	10	10							
	Formic-Acid	10%						6H	6H	10	10							
		50%	6R	6R	6R	6R	6R	6H	10	10	10							
	Lactic Acid	all										6H	10	10				
Alkalis	Sodium Hydroxide	10%	6R	6R	6R	6R	6R	6R										
		25%	6R	6R	6R	6R	6R	6R										
		40%	6R	6R	6R	6R	6R	6R										
	Ammonium Hydroxide	5%	6R	6R	6R	6R	6R	6R										
		10%	6R	6R	6R	6R	6R											
Bleaching/ oxidation solutions	Sodium Hypochlorite	5%	6R	6R	6R	6R	6R	6R										
		12%	6R	6R	6R													
	Chlorine Dioxide	15%	6R	6R	6R	6H	5H	5H	5H									
	Hydrogen Peroxide	10%	6R	6R	6R	6R	6R	6H	5H									
	Chlorine Water	satu				6R	6R	6R	6H	6H	5H							
Gases	Chlorine Gas	—				6R	6R	6R	6H	6H	2001	2001	2001	2001				
	Hydrochloric Acid Gas	—											2001	10	10	10		
	Sulfur Oxide Gas	—														10	10	10
	Sulfuric Acid mist	—														10	10	10
Salts	Acidic and Neutral	all												6H	10	10		
	Alkaline	all																
Organic Substances and Solvents	Formaldehyde	37%					6R	6R	6H	10	10							
	Benzene	all	6H	6H	6H	6H	6H	6H	10	10								
	Toluene	all	6H	6H	6H	6H	6H	6H	10	10	10							
	Styrene	all	6H	6H	6H	6H	6H	6H	10	10	10							
	Methanol	all	6H	6H	6H	10	10											
	Acetone	all	6H	6H	10	10	10											
	Trichloroethylene	all	6H	6H	6H	6H	10	10	10	10								
	Chloroform	all	6H	6H	6H	10	10	10										
	Carbon Tetrachloride	all	6H	6H	6H	6H	10	10	10	10								
	Ethylene Dichloride	all	6H	6H	6H	10	10	10										
	Carbon Bisulfide	all	6H	6H	6H	6H	10	10										
	Phenol	10%	6H	6H	6H	6H	6H	10	10	10	10							

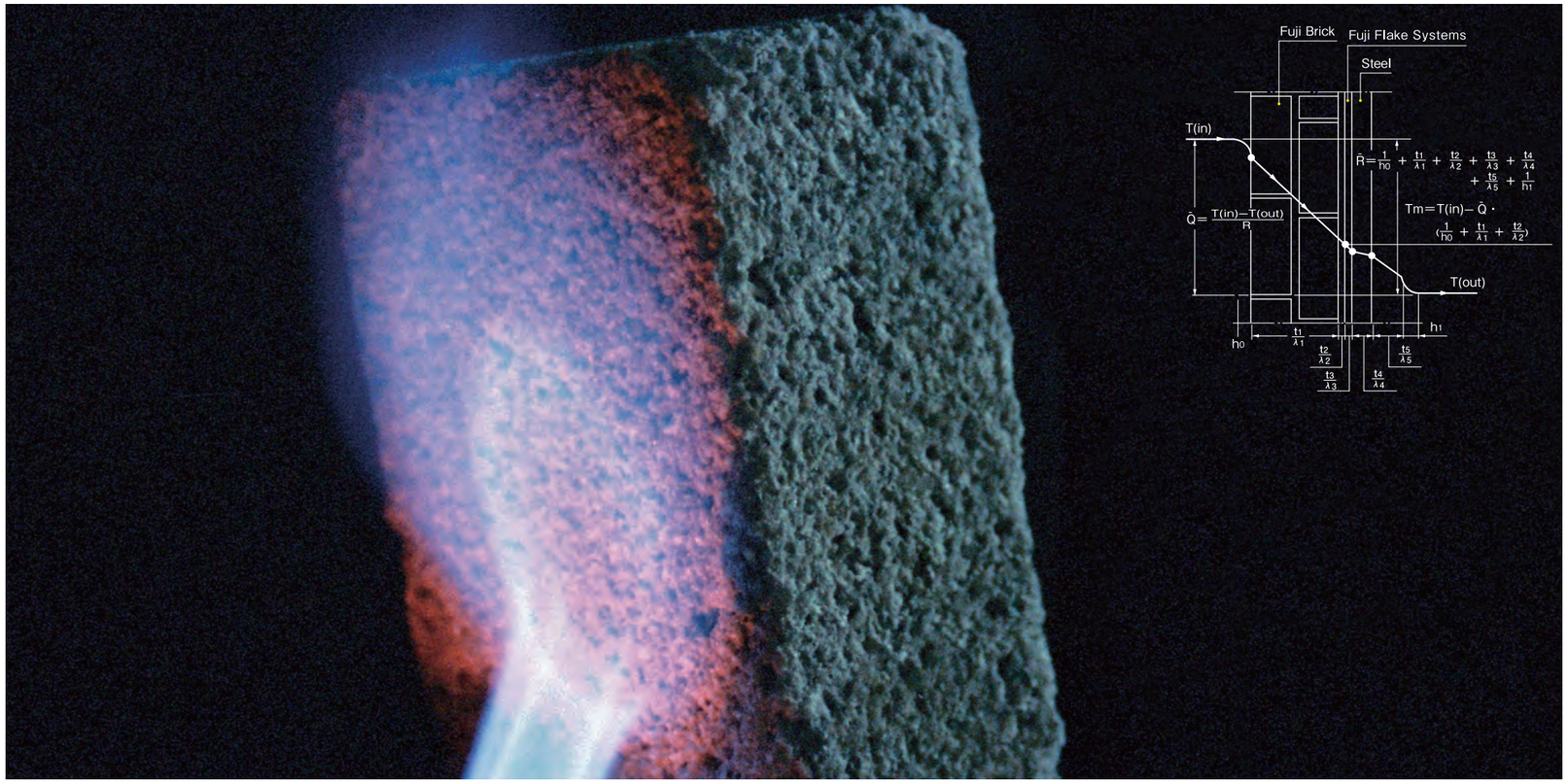
Note: The above table only serves as a guideline. Therefore consult us before determining materials.
＊ Hydrofluoric acid resistance is an optional specification.

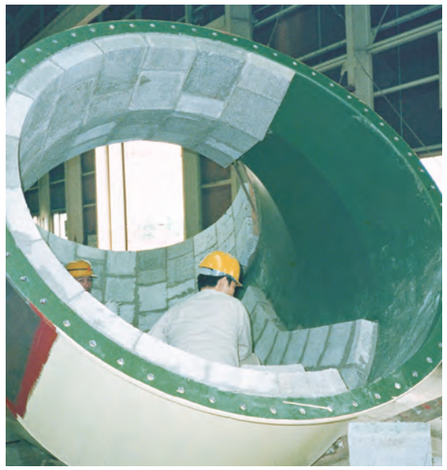
• Comparison with Rubber and Corrosion-proof Metals



Fuji Flake #6H
Fuji Flake #6R
Fuji Flake #6S
Fuji Flake #5H
Fuji Brick System

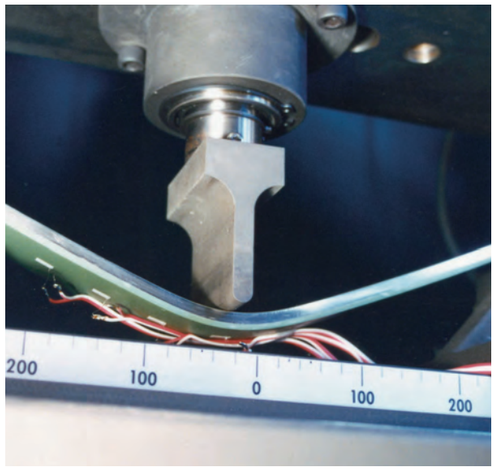
6H Fuji Flake #6H-AR
6R Fuji Flake #6R-AR
6S Chemeq-Line#6S
5H Chemeq-Line#5H, CL #5805
10 Chemeq-Line#10, CL #5810
2001 Chemeq-Line#2001





FUJI FLAKE and X-9000,combined lining being applied to a flue gas desulfurizing inlet duct

Continuous acid picking lines, Fuji Flake AR/X-9000



Responding to Thermal Stress, Deformation and Fatigue under High Temperatures

Heat Resistance and Flexibility Properties

Fuji Flake Lining exhibits little residual stress at curing, a coefficient of thermal expansion approaching that of metal and superb adhesive qualities on metal and concrete structures. Furthermore, its heat-resistance is stable over long periods.

• Heat Resistance of Fuji Flake

Grade	Heat Resistance (℃)	
	Liquids	Gases
Fuji Flake #6H	120	150
Fuji Flake #6R	90	100
Fuji Flake #5H, #6S	110	130
Fuji Flake #3, #4	80	90
Fuji Flake SL #6300	130	160
Fuji Flake SL #6100	100	120

Combined use with Fuji Brick increases the heat-resistant and insulating properties of Fuji Flake in environments where its heat-resisting limit is exceeded.
Fuji Brick X-10, as it is jointless, demonstrates corrosion preventing functions more reliably at a maximum heat resistance of 200 °C.
Fuji Brick X-9000 excels in sudden heating and cooling and in spoiling resistance with a maximum heat resistance of 800 °C. It is used in various areas including hot gas cooling towers in garbage incineration plants and iron and steel pickling lines.

• Physical Properties of Fuji Brick

Properties		Fuji brick X-9000	Fuji brick X-10	Brick (Acid-Proof)
Bulk Density		1.3～1.5	1.3～1.4	2.1～2.2
Porosity	(%)	20～25	8～15	8～13
Water Absorption	(%)	8～12	4～6	4～6
Compressive Strength	(MPa)	5.0～10	11～14	59～69
Flexural Strength	(MPa)	1.5～2.5	3.9～4.9	20～29
Thermal Conductivity	(W/(m•K))	0.2～0.5	0.4～0.5	0.9～1.1
Coefficient of Thermal Expansion	(1/K×10⁻⁶)	0.3～0.4	12～13	4～6
Heat Resistance	(℃)	800	200	200

Fuji Flake Lining possesses excellent adhesive flexibility properties against deformation and fatigue. In a fatigue test where dual amplitude stress of 245 MPa is applied to carbon steel SS400, no abnormalities are found in Fuji Flake whereas carbon steel started to crack at around 570,000th test and eventually broke.
Ordinarily, safety is further improved as it is designed at allowable stress values lower than the yield point.
Fuji Flake AR demonstrates excellent flexibility properties in local deformation. And Flake Flex is best suited to concrete structures where high adhesive and flexibility are required.

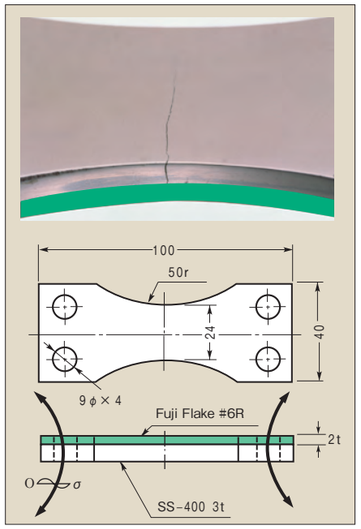
• Physical Properties of Fuji Flake

Properties	Fuji Flake #6R	Fuji Flake #6R-AR12
Tensile Strength (MPa)	39	88
Flexural Strength (MPa)	78	127
Flexural Modulus (GPa)	7.8	7.8
Coefficient of thermal expansion (1/K)	2.0×10⁻⁵	2.1×10⁻⁵
Vapor Permeability (g/m² • 24hr • mmHg)	0.01(1 mm)	0.01(1 mm)
Impact Test (DuPont method) (g×cm)	500×50 passed	500×50 passed
Elongation (%)	0.5	1.5
Tensile Lap-shear Adhesive Strength (MPa)	12	12

• Repeat-Loading Fatigue Test

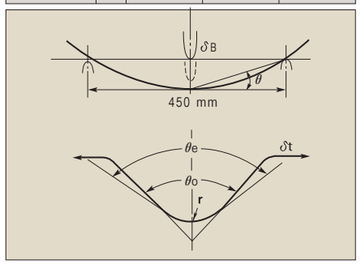
Constant stress type dual amplitude system, repeated bending strength
Conforming to method B of ASTM D671-63-T

Test Piece	Maximum Flexural Stress (MPa)	Result
Base metal (Carbon steel SS400), Lining material (Fuji Flake #6R 2 mm)	196	10,000,000 times. No abnormalities
	245	570,000 times. Cracks in carbon steel. No abnormalities in Fuji Flake Lining.



• Adhesion and Flexibility Test

Test		Fuji Flake #6R	Fuji Flake #6R-AR	Flake Flex #501
Bending Deformation, (θ)		4°	8°	No breakage
Corner Deformation, (θe-θo)	10r	1°21'	3°30'	6°10'
	30r	2°10'	4°40'	9°or more



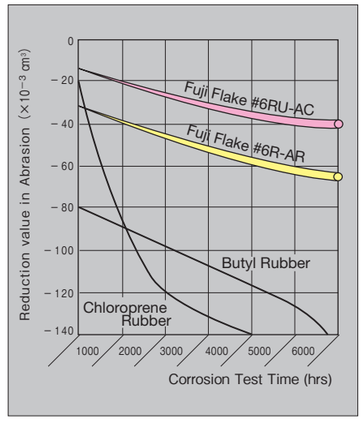
Flue gas desulfurizer absorption column and cooler — FUJI FLAKE AC

(Top)Rotary scrubber AC-coat composite
(Center)Phosphate rock agitators Fuji Flake AC

Fuji Flake AC (Abrasion and Chemical resistance) demonstrates particularly well against abrasion, erosion and other physical damage. It also demonstrates abrasion and high corrosion-resistant qualities that cannot be achieved by rubber in situations where agitation, splashing of liquids, slurry abrasion and corrosion resistance are required.
Even the corrosion of materials that initially are highly abrasion-resistant is accelerated when deterioration caused by chemicals once sets in. The performance of Fuji Flake AC is stable as it outstandingly resists corrosion and abrasion even against hydrofluoric acid. Its high abrasion resistance has been put to the test on chemicals containing slurry in coal-fired FGD plants and phosphate rock agitators.

- **Abrasion Resistance of Fuji Flake AC (In-house comparison values)**

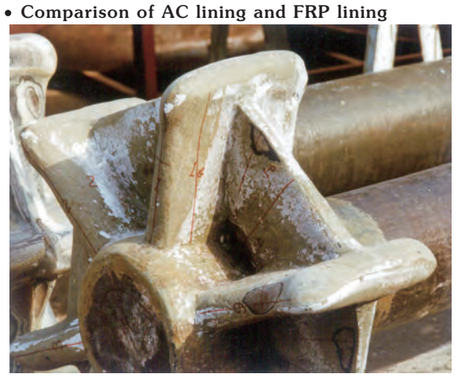
After Corrosion Resistance Test (5% H_2SO_4 at 80°C)
Taber Abrasion Test (CS-17, 1000g/1000 cycles)



- **Physical Properties of Fuji Flake #6RU-AC**

Properties	Unit	Fuji Flake #6RU-AC
Tensile Strength	MPa	59
Flexural Strength	MPa	98
Flexural Modulus	GPa	7.8
Tensile Lap-shear Adhesive Strength(on SS400)	MPa	14
Bendability (4.5mmt steel, 450mm span)		Cracks at 3°
Impact Test (DuPont method)	g×cm	500×50 passed
Coefficient of Thermal Expansion	1/K	2×10^{-5}

- **Comparison of AC lining and FRP lining**



AC lining is no abrasion.
(Operation terms: 12 Months)

FRP lining is abrasion.
(Operation terms: 6 Months)

Outstanding Abrasion Achieved through Composite of Various Properties

Abrasion Resistance

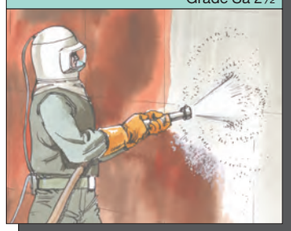
A Standardized Processing System Built up from a Firm Track Record

Based upon years of experience in the field, our experienced technicians and personnel have completed development of a corrosion-proof barrier that brings out the qualities of Fuji Flake to their full.
The Application methods and specifications for facilities and equipment to be lined vary greatly. They are determined by the running conditions – chemicals used, temperature and pressure – the type of structural material, work conditions and time available for application.
Our specialist personnel plan economical anti-corrosion programs to fit newly arising needs. These programs cover a broad area, form a major part of a complete system and deliver reliability to our customers.

Vessel Design・Fabrication

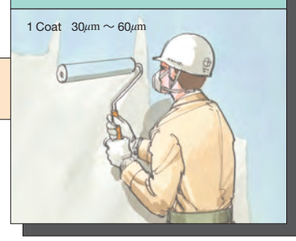
Surface Finish Inspection

1 Blasting
ISO 8501-1
Grade Sa 2½



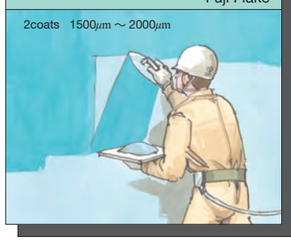
2 Primer Coating

1 Coat 30μm ～ 60μm



3 Trowel Application
Fuji Flake

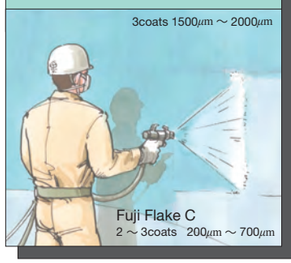
2coats 1500μm ～ 2000μm



Safety and Quality Control

3 Spray Application
Fuji Flake SL

3coats 1500μm ～ 2000μm



Fuji Flake C
2 ～ 3coats 200μm ～ 700μm

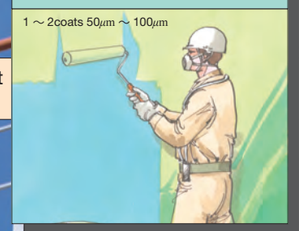
Attachment Lining

High Corrosion Resistance・Flexibility
Fuji Flake AR

2000μm ～ 4000μm

4 Top Coating

1 ～ 2coats 50μm ～ 100μm



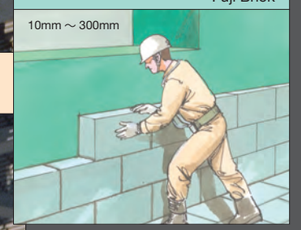
Abrasion Resistance
Fuji Flake AC

2000μm ～ 4000μm

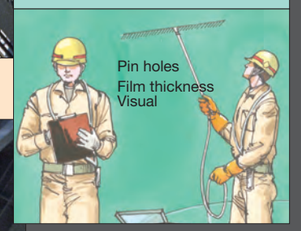
Cold Curing

Highly Heat Resistance
Fuji Brick

10mm ～ 300mm



5 Final Inspection



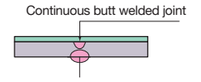
Highly Chemical Resistance
Chemeq-Line

1000μm ～ 5000μm

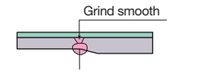
Precautions in Fabrication of Vessels

When carrying out complete anti-corrosion work in your lining equipment, you should pay attention to the points given below. Consult us further for details.

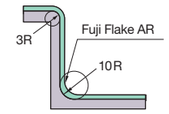
1 Avoid lap welding joints. You should use continuous butt welded joints only.



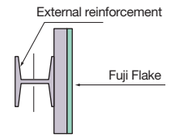
2 Sharp edges and rough areas on the surface should be ground flush.



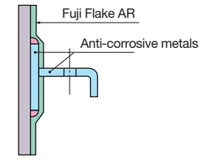
3 Finish the convex sections of corners to radius 3 mm or more and the concave sections to 10 mm or more. Consult us before determining how to finish the corners of large tanks and square ducts.



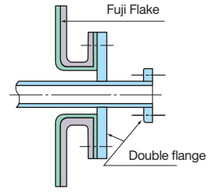
4 Structural reinforcements such as angles, channels, I beams and other members should be installed on the exterior. Fully reinforce parts where concentration of stress or deformation is likely to occur.



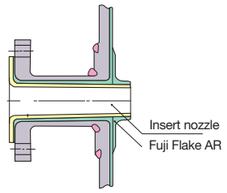
5 Avoid complicated shapes and angles which are difficult to line. When using corrosion-resistant metal attachments, in principle avoid welding directly to the carbon steel vessel. A foot plate should be used.



6 Use double-flanged insert piping system for steam-heated pipes, shower pipes and thermometer protection pipes.



7 Small-diameter nozzles should be carried out in accordance with the Fuji-Chemeq standard FRP insert system. In this system, the finished inner diameter is smaller than the steel nozzle. Remember this when the size of the inner diameter is limited.



8 After lining, the lining will become burnt and damaged if the positions of the parts are changed or external support holders, etc. are welded. If this is absolutely necessary, implement fire prevention measures and measure to prevent the spread of heat.

A Broad Spectrum of Applications

Rapid technological progress has resulted in a trend towards higher grade,more diversified and energy-saving facilities in all areas of industry.
Fuji Flake lining demonstrates all the required qualities, aptly meets the high-grade needs for preventing corrosion and is used extensively in all areas of industry.

Thermal power plant with a background of industrial complexes — Fuji Flake

• Steel, Non-ferrous Metals and Surface Treatment

Discharge gas treatment, ducts and stacks, sintering, COG, household power generation, refinery plants continuous acid pickling lines, alumite processing lines, plating lines, EGL lines, waste water and acid treatment plants

• Public Works and Construction

Municipal garbage incineration plants water purification plants, activated carbon absorption, water supply, setting tank and storage tanks, chemical tanks, water reception tanks, hot water supply pipes and prevention of concrete corrosion

• Chemicals and Petroleum

Reaction, blending, neutralizing, mixing and separating vessels distilling, refining, absorbing and refracting towers, chemical tanks, process piping, and heat exchangers

• Fiber and Paper Pulp

Boiler gas treatment plants, processing chimneys, ducts, tank lorries, fans and blowers, pumps, agitators, spinning baths, chest and pits for papermaking

• Other

Vessels for foodstuffs, confectionery, electricity, electronics and medicine • Shipping, marine structures, marine development, desalination of sea water • Railway, automobile and airport facilities

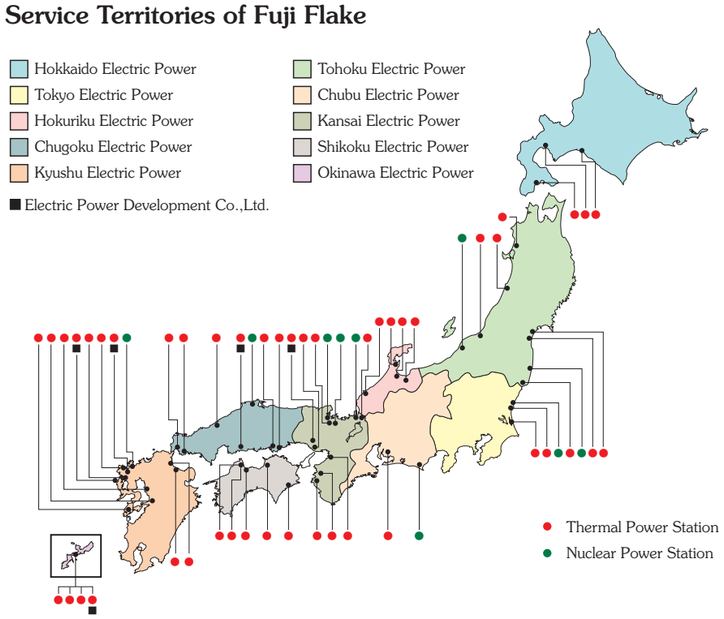
Preserving Nature and Contributing to Environmental Safety Achievements in Power Generation

Fuji Resin boasts more than 45 years of operations and a sales record of more than 200 units of flue gas desulfurization plants installed at oil-and coal-fired power generation. All of these units support the desulfurization and denitration processes of plant manufacturers and are earning wide acclaim.
They are also in use in chemical tanks, waste gas ducts, electrostatic precipitators, GGH, stacks • raw, pure and hot water tanks • heavy oil, crude oil and kerosene tanks • wharfs, harbors, and cooling water route facilities • supply and waste water processing units, and nuclear power generating facilities. In this way, we contribute to protecting nature and environmental safety in Japan.

5300Φ×200ᵐH stack Fuji Flake-lines (Top-collected areas)

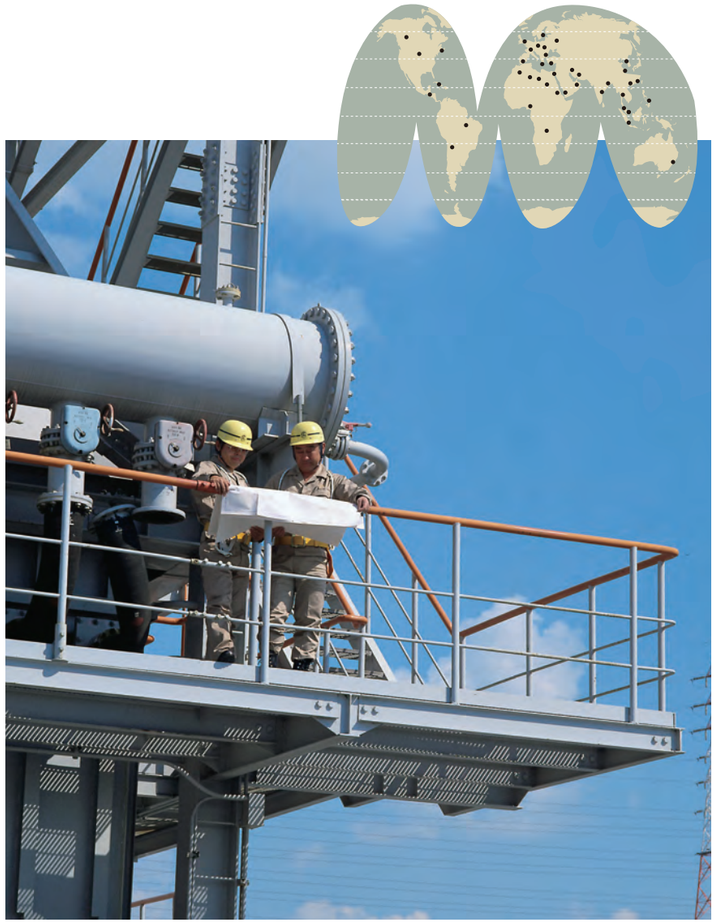
Photo/Presented by The Sankei News Paper

Service Territories of Fuji Flake



Panoramic view of a thermal power plant (EPDC) in Japan — FUJI FLAKE-lined

Firm Reliability through a Thorough, All-round System Corrosion Engineering Service



Fuji Resin brings alive leading edge technology and an abundance of experience and know-how. To most economically and promptly satisfy users' requirements, we are firmly committed to implementing all operations involved in corrosion engineering-production of corrosion preventing materials, materials evaluation, corrosion-control designs, construction and maintenance.

- **Technical Service**

To achieve our corrosion control plans each of the departments for technology, production, construction, quality and safety is engaged in standardization, modification and upgrading in a concerted effort to improve reliability.

- **Construction Services Afforded by a Global Network**

Experienced personnel manage construction at the local level. They ensure that on-site management proceeds safely and smoothly.

- **Maintenance Services**

We carry out maintenance measures for facilities and offer advice through the most advanced life research and upgraded technology to maintain safe operations after jobs are completed.

- **Overseas Services**

Against a diversifying international climate, our overseas activities include the export of materials, local procurements and the dispatch of technical advisers so that we can heighten the reliability of our users' projects.

FUJI'S CORROSION CONTROL SERVICES

Flake Lining Systems	FUJI-FLAKE
FRP Lining Systems	CHEMEQLINE. LOOSE-CHEMEQ
Brick Lining Systems	FUJI-BRICK. FUJI-MASTIC
Concrete Protection Systems	POLYCRETE. HQ-MORTAR. HIMAX FUJI-FLOR. FOODLINE-M
Coating Systems	FUJI-COAT. FUJI-FLON. FOODLINE
Sheet Lining Systems	FUJI-LINER-UV. FUJI-SHEET
FRP Composite Systems	FUJI-CHEMEQ. GP.

Tanks. Vessels. Towers. Stacks. Ducts. Tank-lorry. Pipes. Rolls
Pumps. Fans. Steam-silencers. Agitator

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