COSMO COAT

(Super Heat Resistance Ceramic Coating)

Patent filed in Japan

TRADE SERVICE CORPORATION

Osaka Japan

Tel;06-6392-1313 Fax;06－6392－1403

Mail ; info@ts-corp.biz

Development history and concept of COSMO COAT

Development history;

Regarding the initial Japanese rocket launch technology, it was developed as a ceramic coating agent for the purpose of improving the high temperature heat resistance durability of metal parts used in rocket boosters in solid fuel experiments.

However, the rocket booster only needs to have heat resistance of about several minutes after launch, but a high-temperature and durable coating agent used in consumer products was required. In addition, heat-resistant metals (Ni-Alloy, etc.) are extremely costly and difficult to use except for limited equipment and materials. Therefore, by applying a ceramic coating to a low-priced metal (Ex: iron, stainless steel, etc.), a new material that is low-priced and has excellent high-temperature durability was investigated.

Development concept;

*There is a large difference in the number of expansions between metals and ceramics, and absorption or follow-up of this expansion coefficient. It is necessary to develop a such ceramic coating agent

. * In order to improve the heat resistance of metal, the degree of freedom of construction is higher than the currently widely used thermal spraying. Moreover, it has a cost merit and maintains excellent performance.

* Being friendly to the work environment and health and having excellent storability.

* The materials used have no environmental or human impact and can comply with the strictest environmental regulations. In principle, it is a completely waterborne pure inorganic material and does not contain any heavy metals.

What is COSMO COAT;

What is Cosmo Coat:

A two-component mixed type that uses an alkali metal silicate compound as a binder and forms a high-temperature oxidation-resistant metal ceramic membrane on the surface of the metal base material and the Cosmo coat at the interface of the metal base material using heat-resistant aggregates such as alumina, zirconia, and silicon and a low melting point catalyst. It is a coating agent of. There are two types of ceramic coating parts formed by adjusting the particle size of the aggregate: COSMOSIC, which is a dense coating, and KH-400 series, which has closed cells inside the coating to prevent the expansion of cracks. It is a new material that follows the coefficient of thermal expansion that does not cause cracks or peeling on the membrane. It is possible to apply Cosmo coat to a Stainless Steel base material with a high expansion coefficient in the ultra-high temperature range of 800 to 1350℃, which other companies cannot follow in the field where it is most strong in the operating temperature range. In particular , when the temperature exceeds 1000℃, expensive Ni-Cr alloys are often used, and by applying Cosmo coat to metals such as SUS310 and SUS316, it is possible to replace Ni-alloy metals, which is not possible with thermal spraying. It works well even in areas where the possible atmospheric temperature exceeds 800 ℃.

In the future, we will make the best use of the advantages of Cosmo coat in the field of on-site construction and heat-resistant construction of parts, and plan to develop it using thermal spraying as a benchmark.

Advantages;

(1) Short construction period (about 1/3 to 1/4 of thermal spraying)
(2) Low price
(3) Partial repair and touch-up possible
(4) Environmentally and human-friendly
(5) Good working environment
(6) Good material storage (toxic gas, odor, flammability,Nothing)

Types and uses of Cosmo Coat

Cosmo coat for metal; (COSMO327, COSMOSIC, KH-400 series)

The Cosmo coat membrane adheres to the metal surface and prevents the intrusion of high-temperature gas to prevent high-temperature oxidative deterioration of the metal. In addition, although the composition of the incinerated ash differs depending on the combustion substance, the boiler water pipe is corroded by chlorides, sulfates, etc. from the attached clinker. Further, when Zn or Pb is contained, the melting point of the incinerator ash is lowered and the fly ash easily adheres to the boiler water pipe. The higher the temperature of the boiler water pipe, the more severe the corrosion. Cosmo coat for metal, a ceramic membrane is formed on the surface of the boiler water pipe (super heater, etc.), mainly at high temperatures to prevent high temperature gas and clinkers from coming into direct contact with the forbidden part, thereby reducing the thickness of the boiler water pipe. The purpose is to protect from the oxidation of metals exposed to the oxygen atmosphere due to high temperature.

Cosmo coat for refractory (COSMO327B, COSMO327BS)

Cosmo 327B and BS forms a glassy membrane on the surface of the refractory at a relatively low temperature (about 950 degrees), reduces the intrusion of high-temperature gas into the refractory, prevents spalling, and delays the adhesion of flying ash generated in the furnace. This has made it possible to extend the service life of various thermal furnaces, including incinerators, by simplifying maintenance and extending the life of refractories. In addition, the improvement of total reflectance due to the Cosmo coat effect greatly contributes to fuel reduction (Co2 reduction). Can be used for refractories in any high temperature furnace.

Cosmo Coat Introduction

Please see attached Video at HP

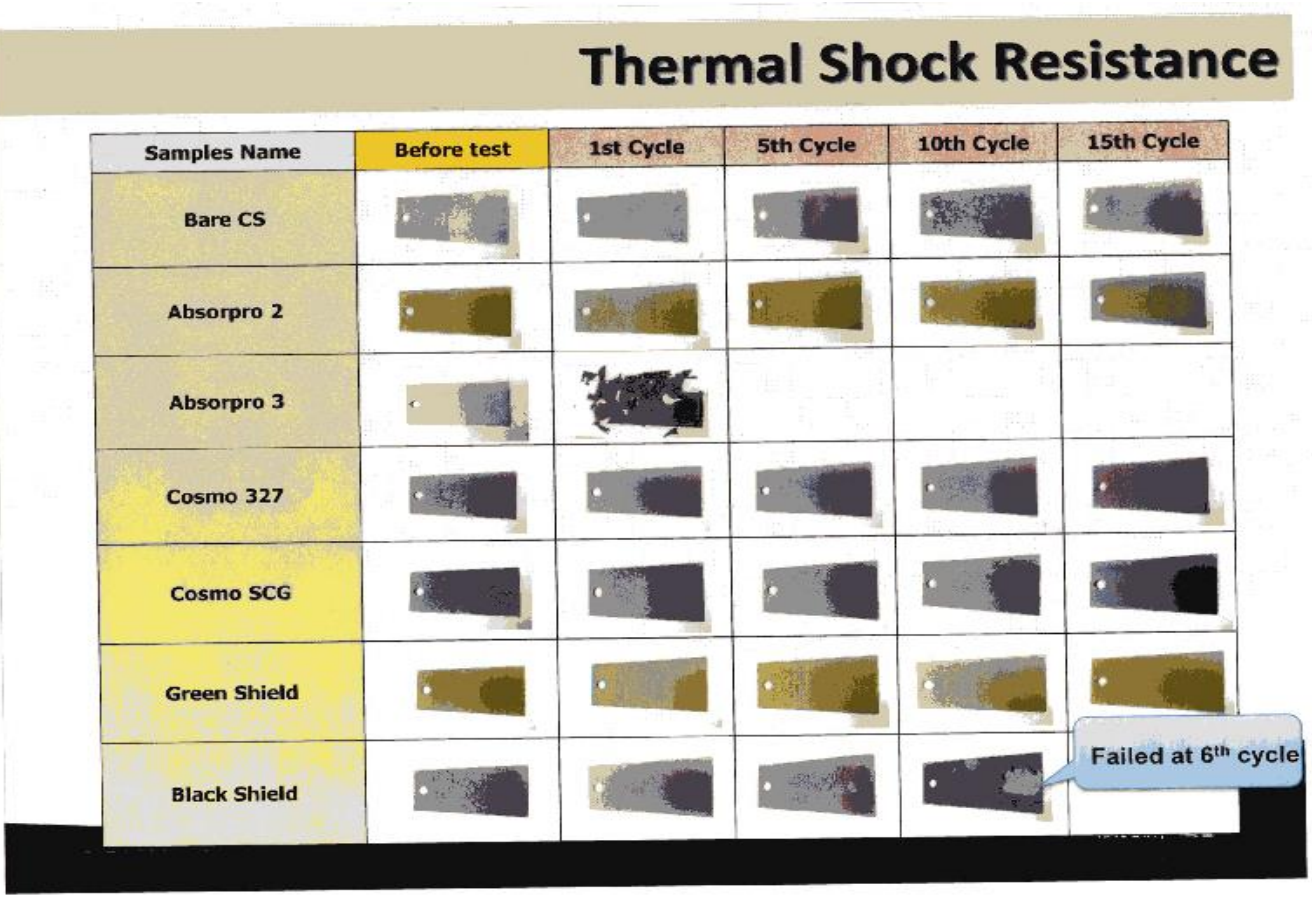
Comparison test of various heat resistant coating agents and Cosmo Coat

Comparative test material:

- COSMO327 (manufactured by TSC, for metal)
- COSMOSCG (COSMOSIC) (manufactured by TSC, for metal)
- Absorpro Gen2 (made overseas)
- Absorpro Gen3 (made overseas)
- Green Shield (made overseas)
- Black Shield (made overseas)
- Bare CS (Bare carbon steel)

Thermal Shock Resistance

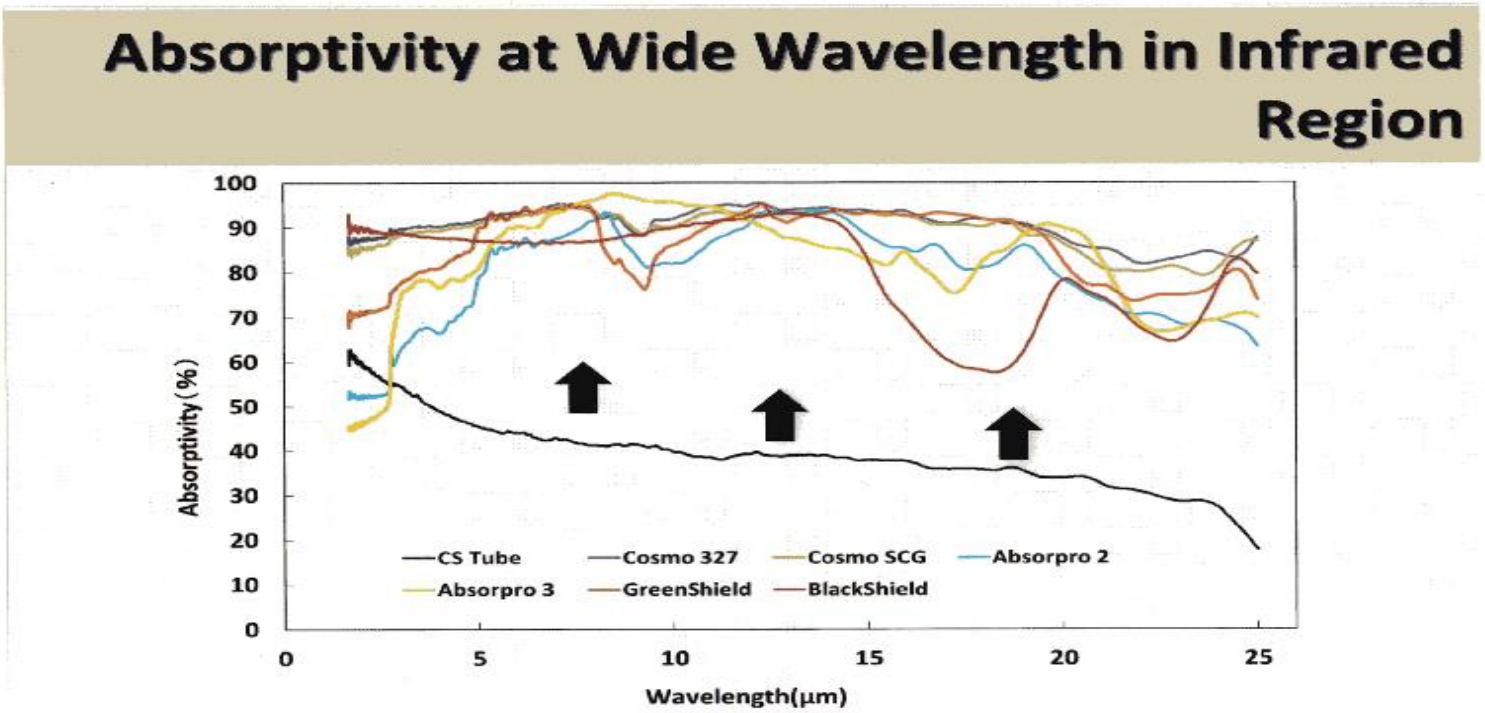
(Weigh the sample repeatedly at room temperature to 800℃15 times)



Absorptivity at Wide Wavelength in Infrared Region

(Comparison of infrared absorptivity for each wavelength of each material

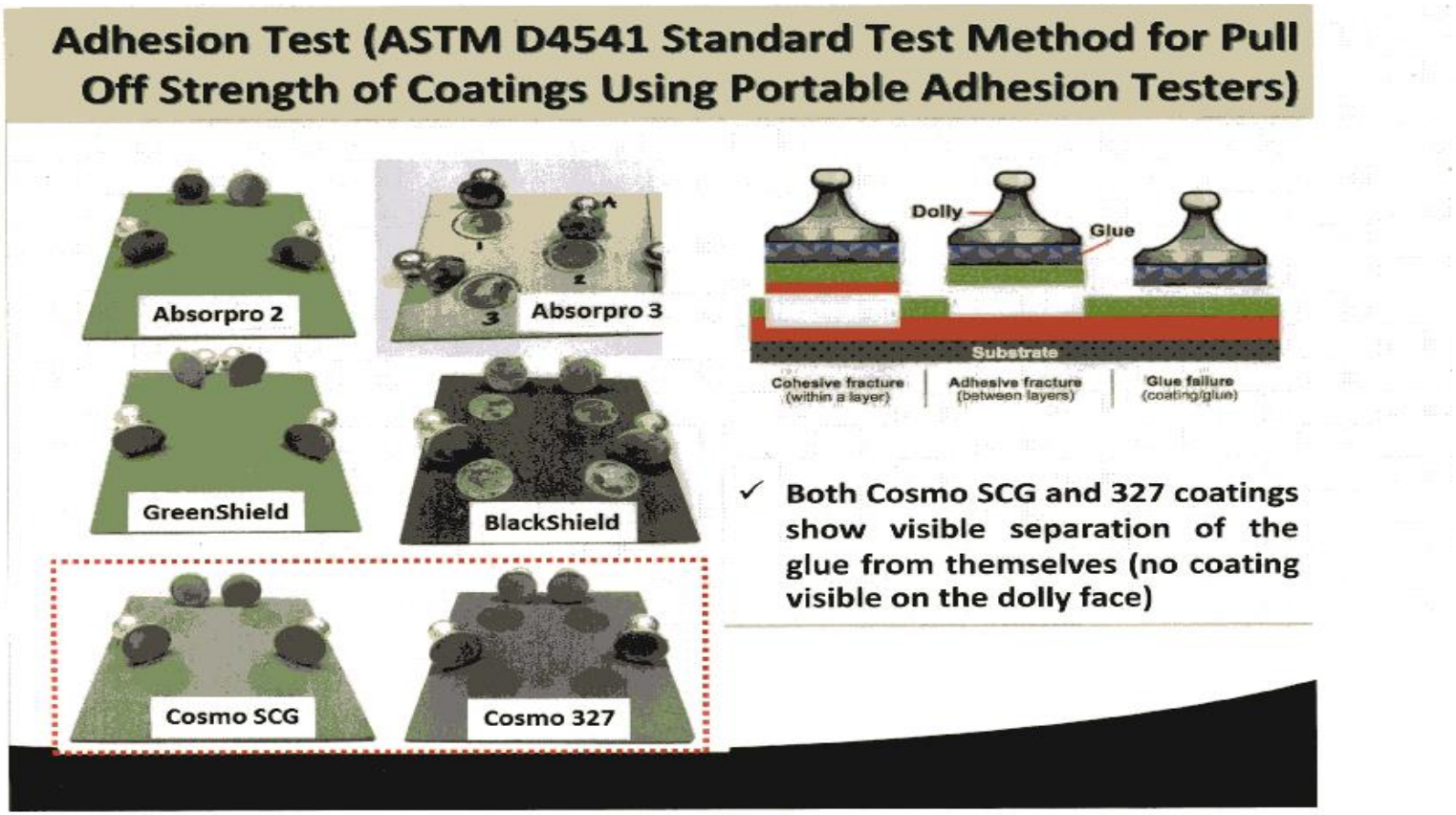
(total infrared emissivity)



✓ Both Cosmo SCG and 327 coatings enhanced absorptivity of the carbon steel for whole wavelength in infrared region. This is main benefit of the coating in terms of energy.

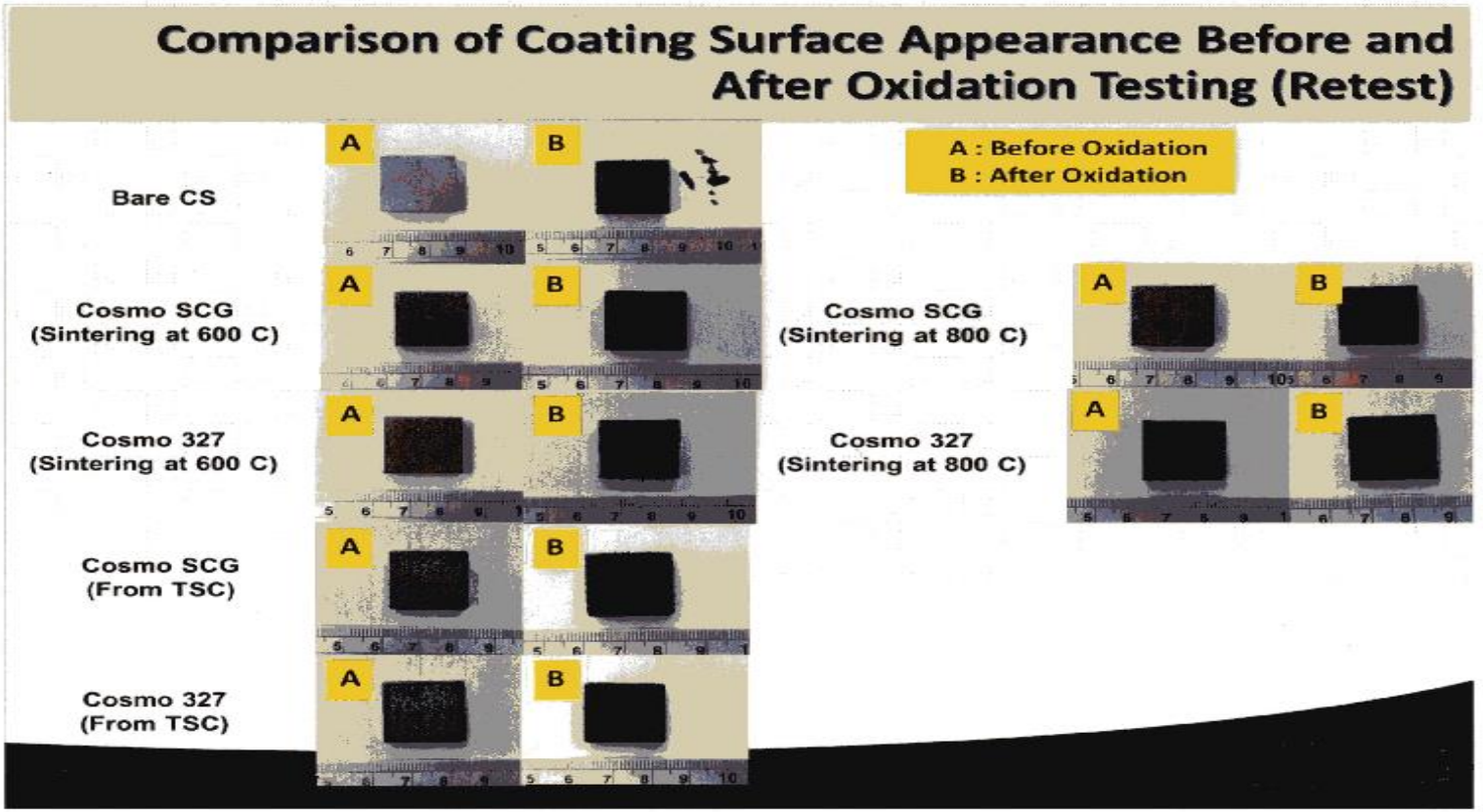
Adhesion Test(ASTM D4541 Standard)

(Adhesion test: Verification of adhesion of each material)



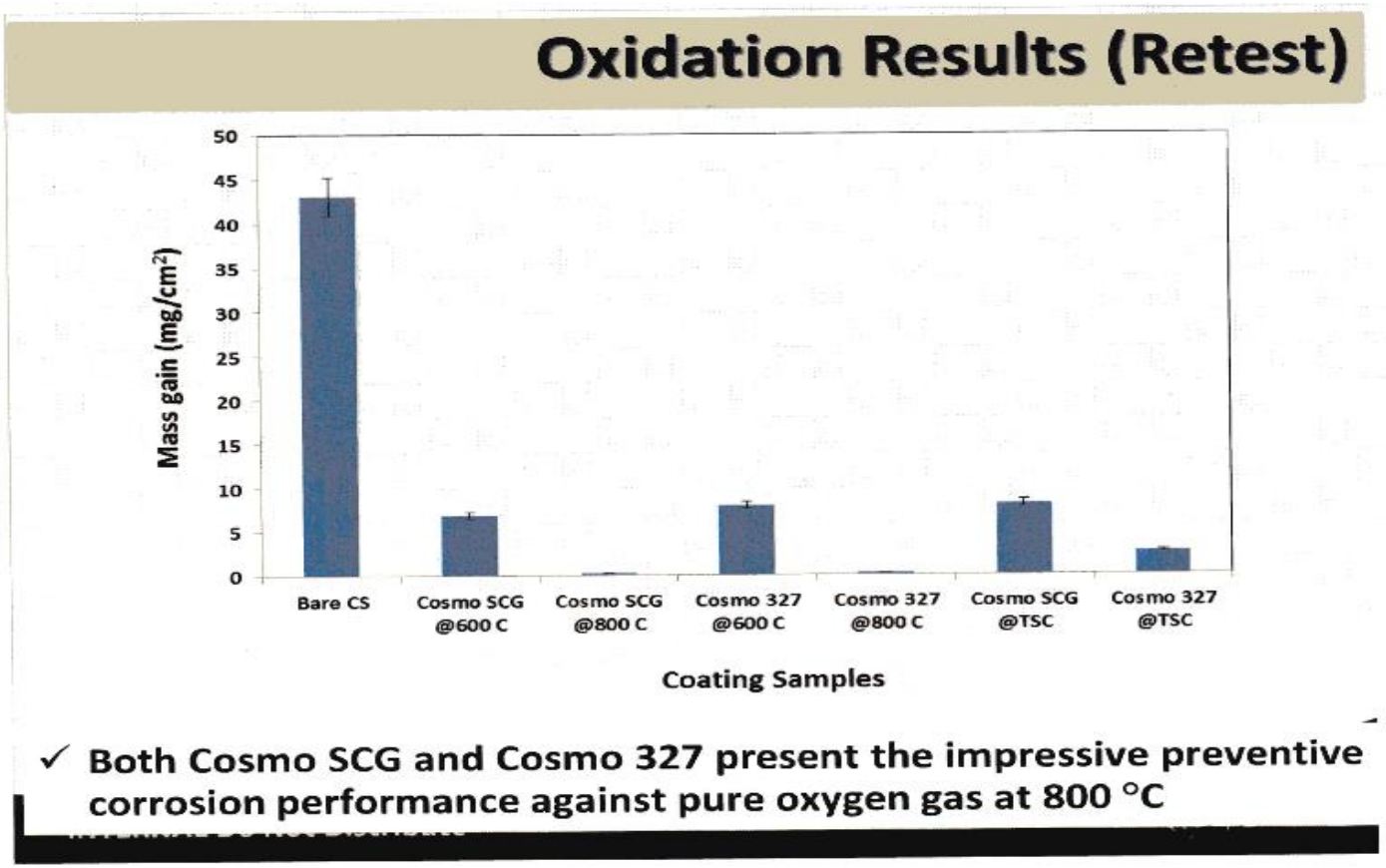
Comparison of Coating Surface Appearance Before and After Oxidation Testing

(Visual conditions before and after heating each material at 600 ℃ and 800 ℃)



Oxidation Results

(Test results after heating; Oxidation durability test results at 800 ℃ and under pure oxygen)

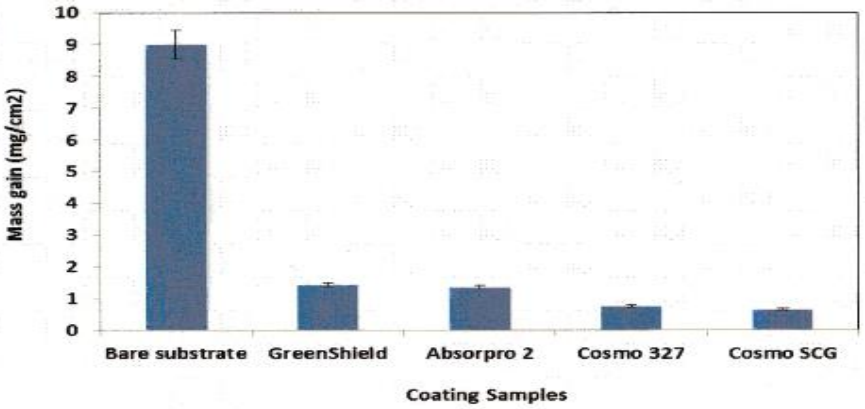


High Temperature Corrosion Test

(Oxidation durability test results in air atmosphere at 800 ° C for 24 hours)

High Temperature Corrosion Test (Ambient Gases)

➢ Heat to 800 °C (Temp ramp for 40 mins) for 24 hours



✓ Our developed coatings present the impressive preventive corrosion performance against ambient gases at 800 °C

Cosmo coat mechanism (for metal) 1

- Inorganic heat-resistant aggregates such as alumina, silicon, zirconia, and manganese dioxide are combined with materials that lower the melting point of inorganic materials such as zinc oxide, zinc borate, and sodium tetraborate, and alkali metal compounds (water) are used to make this into agent. Apply to metal using this agent. When tentatively fired at about 250℃ to stabilize and fix the membrane, the inorganic material adheres to the metal surface due to the adhesive force of the glass-based solvent. After that, when the temperature is raised, the melting point material softens the surface of the inorganic material at around 800 to 900℃, and the manganese metal is integrated with the inorganic material while forming a membrane on the metal surface of the base material. Inorganic material particles are a combination of large and small, and those with a large specific gravity float on the bottom and those with a small specific gravity float on the top to form a metallic ceramic compound in which a manganese metal and an inorganic base material are mixed at the interface with the base metal, and the upper part of the coating is ceramic. A porous situation is formed. This degree of porosity covers the followability of the expansion coefficient of the metal.

Cosmo coat mechanism (for metal) 2.

However, in the porous state, high-temperature oxygen gas attacks the metal base material and oxidation occurs, but the manganese metal is resistant to oxidation and protects the metal base material, so the oxidation phenomenon does not occur. The alkali metal silicate compound used as an adhesive loses its adhesive strength at about 850℃, but the ceramic softened by high temperature and the manganese metal join hands with the base metal to form a metallic ceramic compound. Therefore, it exhibits a membrane formation such as metal base material-metal ceramic compound-ceramic, and exhibits the form of functionally graded material. If the membrane thickness is about 300 microns or more, stress due to the expansion coefficient is large, so cracks and peel off may occur, so basically a membrane thickness of 80 to 300 μm is ideal. Also, since it is used in a high temperature atmosphere, abrasion resistance is not taken into consideration. Incinerators generate a lot of abrasion, basicity, and acid gas, and have not been tested, but they are expected to be effective especially in a high-temperature oxygen atmosphere.

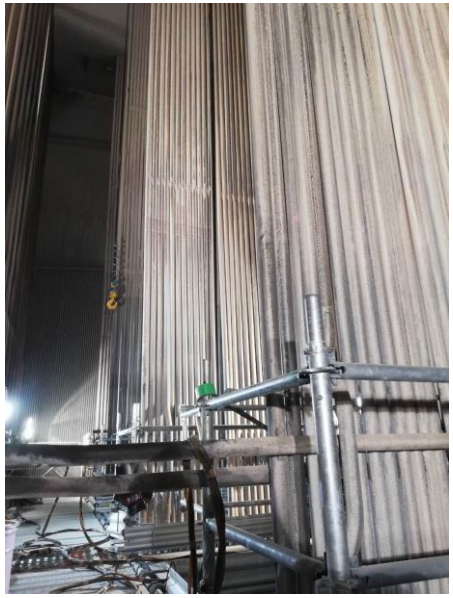
COSMOSIC water cooling thermal shock test

(water cooling test from 1000℃)

Please see attached Video at HP

Coal-fired power plant

（Cosmo coat construction example）



Thermal power plant water pipe wall, super heater & manhole cover, etc.

Example of use; boiler water pipe wall

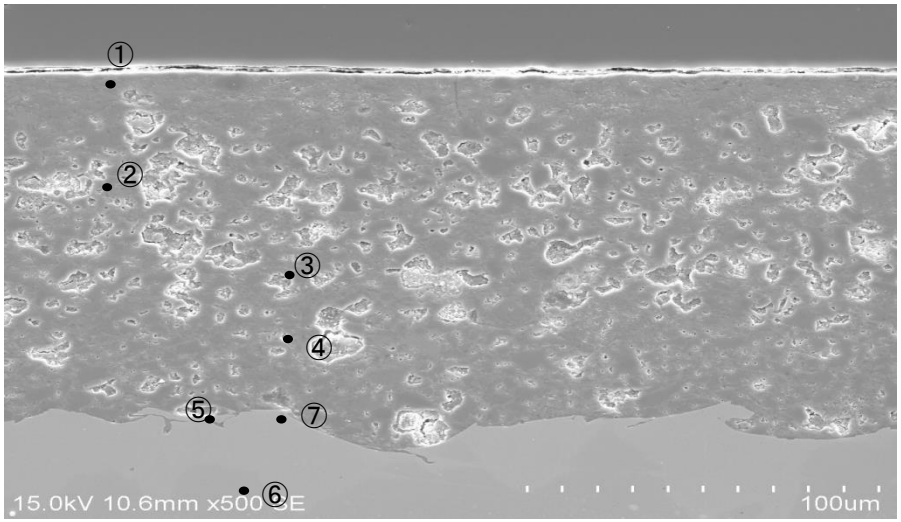
Oil plant company coal-fired power plant

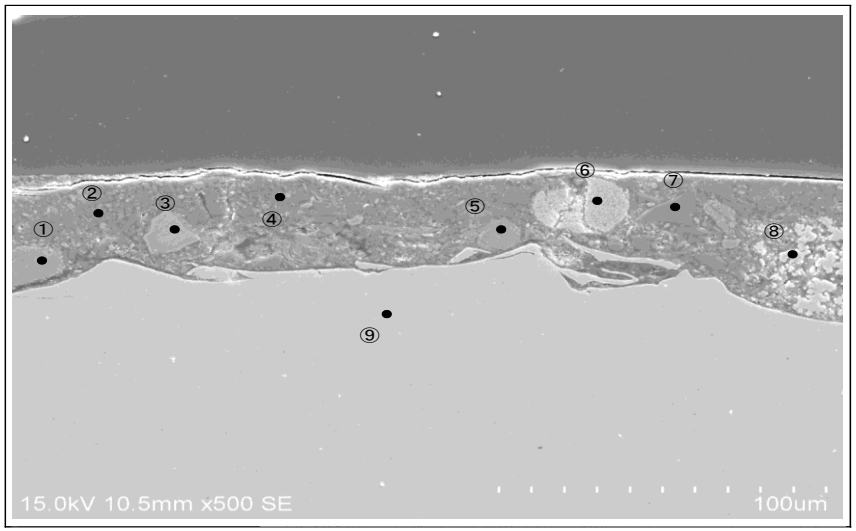
Burner part, cast / water pipe,

swirler

Cosmo coat application to waste incinerator water pipe wall and studs (stud pin wall thinning measures)

Gasification and melting furnace thermocouple operating temperature range 1200 ~ 1350 ℃





Photograph after applying KH-400 to a thermocouple

KH-400: 864Hr at 1200 ~ 1350 ℃ Continuous within the atmospheric temperature Adhesion between the coating and the base material after operation (inside the gasification melting furnace)

＊By applying to thermo-alloy thermocouple, molten iron reaches 1530 ° C.

Photograph after applying Cosmo-327 to a thermocouple

Cosmo-327; 864Hr at 1200 ~ 1350 ℃ Continuous within atmospheric temperature Adhesion between the coating and the base material after operation (inside the gasification melting furnace)

Properties of refractories and mechanism of Cosmo coat Waste / biomass power generation

(for refractories) 1.

1) Features of refractory bricks;

Refractory bricks are manufactured by solidifying inorganic powder such as silicon and alumina with waterborne solvent, molding and sintering at high temperature. However, since it is manufactured by sintering inorganic powder, the bricks are inevitably porous. It usually has a porosity of about 17 to 25%. When used in an incinerator, clinker due to the spalling phenomenon and incineration ash adheres to the porous bricks. Refractory bricks are made according to various functions by changing the type and composition of inorganic materials in order to cope with not only heat resistance but also spalling resistance and clinker resistance. In particular, zirconium bricks and silicon carbide bricks are high-performance bricks, but they are very expensive.

2) Spalling phenomenon;

When refractory bricks are used at high temperatures, dust, gas, etc. that come into contact with the heated surface permeate from the surface of the refractory bricks to the inside, which causes deterioration of the refractory brick surface. Then, it peels off due to the difference in thermal expansion from the unaltered portion. It is a phenomenon in which the base (alkali) and acid gas generated in the incinerator invade the pores on the surface of the brick, bond the particles of inorganic substances, and chip off from the surface of the brick one after another and collapse. In particular, if gas intrudes into the joints between bricks, it may collapse significantly.

Properties of refractories and mechanism of cosmo coat Waste / biomass power generation (for refractories) 2.

3) Clinker

① Standard refractory (refractory bricks)

When dioxin was not a problem, it was burning at about 800 degrees. If so, the incinerator ash did not melt and the clinker adhered less. After the dioxin problem occurred, it became necessary to burn at high temperature came. Dioxin decomposes when burned at 800 degrees or higher, but Dioxins decomposed at the beginning are resynthesized as the temperature drops. Therefore (range of 800 to 300 degrees), it is necessary to lower it to 200 degrees or less at once. Therefore, water is sprinkled on the combustion gas to cool the gas. At the combustion furnace part If it is burned at about 800 degrees, the temperature will drop due to the addition of new dust, so it is necessary to burn at a high temperature in the combustion chamber and burn at a temperature that does not drop below 800 degrees even if dust is thrown in. Normally, incinerating 1 ton of garbage produces about 10% of ash. 10% of this is fly ash, which is ash of very fine particles and is flying in the incinerator. This fly ash has fine particles that melt at high temperatures and adhere to the furnace wall. This is called clinker. After adhering, the clinker gradually hardens on the surface of the furnace wall and accumulates on top of it.

Cosmocoat mechanism Waste / biomass power generation (for refractories) 3.

When these clinker grows, they cannot withstand their own weight and fall. When it falls, it will fall together with the furnace wall and damage the furnace wall. To prevent this from happening, remove the clinker from the surface of the furnace wall while observing the adhesion of the clinker. However, if the clinker penetrates strongly into the pores of the refractory bricks, the brick surface will be damaged or peeled off together when the clinker is removed, and the brick thickness will be gradually reduced. We will ensure the maintenance of the incinerator and replace the bricks at regular intervals as needed.

② Indeterminate refractory (castable)

The castable furnace wall is made by dissolving the inorganic material of refractory bricks in water and applying it to make it clay-like. When heat is applied, the water evaporates and shrinks, so cracks occur in the furnace wall after heating. Indeterminate refractories (castables) are not as strong as bricks because they do not burn at high temperatures like bricks, and they operate while being repaired in a timely manner.

Cosmo coat mechanism Waste / biomass power generation (for refractories) 4.

4) Effects and functions of Cosmo Coat

Effect of Cosmo coat Countermeasures against spalling

①By forming a metal-ceramic membrane on the surface of the refractory, high-temperature gas does not enter through the pores of the refractory or through the brick joints.

② Correspondence of clinker By forming a metal-ceramic membrane, the molten clinker is even if it adheres to the surface of the Cosmo coat, it will drop by its weight when it reaches a certain thickness so that the clinker does not grow.

Functions of Cosmo Coat

① **Countermeasures**

Against spalling ferrosilicon (a mixture of iron and silicon) and manganese metal are included in the ingredients of Cosmo-coat. These metal mixtures are softened at a lower melting point, and zinc borate is mixed in to protect the furnace wall and to make the metal mixture adhere more strongly to the furnace wall.

Cosmocoat mechanism Waste / biomass (for refractories) 5.

By making such a mixture, the metal begins to adhere to the surface of the refractory while softening at about 800 to 900℃, and the pores of the refractory are sealed to prevent gas from entering the refractory. increase.

② Correspondence of clinker

The Cosmo coat coating is composed of metal particles and inorganic materials such as alumina and silicon, and metal particles and inorganic particles are mixed. Fly ash easily adheres to inorganic particles, but it does not adhere to metal particles weakly and clinker grows. However, when a certain amount of adhesion is reached, it will fall under the weight of the clinker itself. This is Cosmo coat it contains metal particles and adheres only to the fly ash inorganic particles in a pointed manner. Because it has no function. Maintenance by Cosmo coat some clinker remains on the furnace wall. Furthermore, clinker adheres to this and clinker adheres to it. The linker will fall, but while repeating this, the linker will remain on the furnace wall. The amount will gradually increase. Normally, clinker adheres to the surface of the furnace wall by about 5 cm, and one of the measures to prevent spalling is to prevent it from growing any further. However, it is generally difficult to stop growth.

Cosmocoat mechanism Waste / biomass (for refractories) 6.

Applying Cosmo Coat delays the growth of clinker, but when it reaches a certain amount of clinker, it drops the clinker by its own weight. Also, if you apply Cosmo Coat over the clinker, it will be more effective to protect the furnace wall. Maintenance of refractory bricks and incinerators will be easier, and the life of the furnace itself can be expected to be extended. This is the purpose of our maintenance. The incinerator has different clinker adhesion and spalling conditions depending on its structure, combustion temperature, incineration amount, and operation control status. Therefore, it is difficult to simply compare the degree of effect of Cosmo Coat, and it is necessary to judge and evaluate from the experience value so far.

The judgment and evaluation are when the operation is stopped due to the incinerator maintenance period.

① How much clinker is attached?
② How is the clinker attached?
③Is the clinker state a hard-baked state?
④Can it be easily removed in a fluffy state?
⑤What is the residual status of the Cosmo coat film?
And so on.

○

Cosmo coat mechanism Waste / biomass (for refractories) 7.

Normally, iron is vulnerable to high temperature and oxidation and falls off as rust, but by forming a compound with manganese, a membrane that is resistant to high temperature and oxidation can be formed. At high temperatures, the metal compound softens slightly and fills the pores, allowing the metal to follow even when the furnace is shut down. The expansion and contraction of the Cosmo Coat can surely follow the refractory, so the Cosmo Coat does not crack.

COSMO327 B.327 BS application criteria

Please see attached Video at HP

Sprinkle with water and apply to a level where water does not soak immediately.
Left side: Absorbs water, not good Right side: Water remains on the film. good

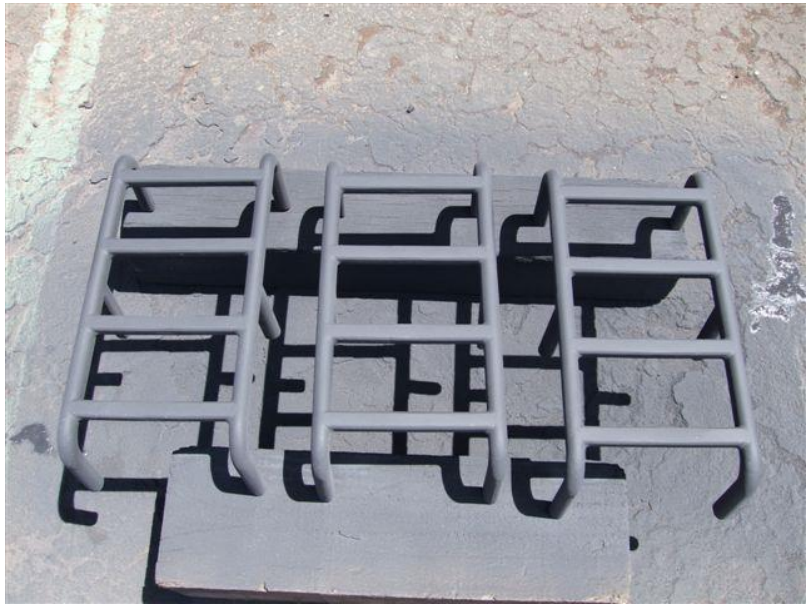
Manhole cover refractory (clinker adhesion status after 6 months of operation) Cosmo coat application non-application comparison

Cosmo coat applied (less adhesion)

Cosmo coat not applied

Clinker can be easily peeled off by hand

Memorial Hall Main Combustion Pot (Lower Right) Trivet (Lower Left)



Use

1. 1. For refractory bricks and Castable;

Incinerator, annealing, electric furnace, heating furnace, biomass power plant, thermal power plant and other thermal furnaces as furnace wall protection, thermal spalling, delay in adhesion of clinker generated in the furnace, prevention of furnace wall collapse, etc.

2. For metal;

*Heating furnace, thermal power plant water pipe wall, super heater, incinerator boiler, biomass Power plant water pipe wall, prevention of high temperature oxidation of super heater, stainless steel of heat exchanger prevention of thinning of pipes.

- Prevention of high-temperature oxidation from radiant heat of the burner nozzle and cover for the thermal
- Furnace effect of improving combustion efficiency by preventing high-temperature oxidation of the heater of the electric furnace and improving total internal reflection.
- Element coating for heat exchangers such as power plants and large boilers
- For industrial heating furnaces for petroleum refining, petrochemicals, steel, metals, etc., and for industrial use and heating Application of boiler wall (ceramic coating on heating tube and furnace wall, hearth)

For high temperature measures of all facilities and equipment used under high

temperature …….

Cosmo Coat Municipal Achievements

*__Inuyama City__, Aichi Prefecture Urban Beautification Center (Incinerator furnace wall / thermocouple, chimney inner wall)

*__Tsukuba City__ Clean Center, Ibaraki Prefecture (2 incinerator walls, thermocouple)

* Funeral hall in __Minokamo City__, Aichi Prefecture (fiFurnace wall, trivet)

* __Tsukuba City__ Memorial Hall, Ibaraki Prefecture (Funeral hall furnace Wall, Trivet)

*__Nagareyama City__ Clean Center, Chiba Prefecture Gasification and melting furnace tuyere / thermocouple

* __Saga Prefectural__ Beautification Center (Crane operation room glass)

* __Nishio City__, Aichi Prefecture Garbage incinerator wall

- __Kagoshima Prefecture Yoron Town__ Waste Incinerator Furnace Wall

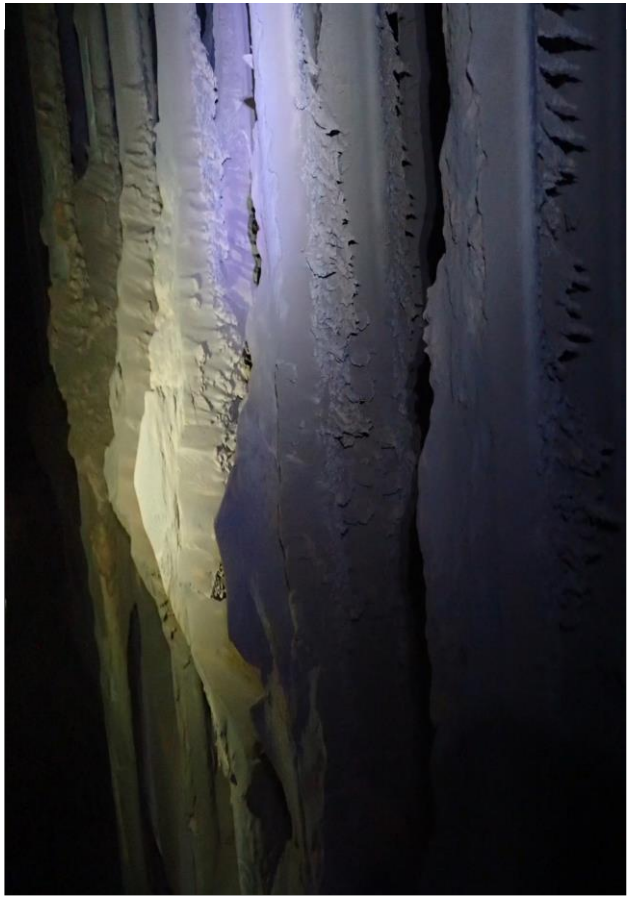
*__others__

Cosmo coat other achievements

- *Iwaki Daio Paper Biomass Power Plant
- * Daio Paper Mishima Thermal Power Station
- * JERA Hirono Thermal Power Station Unit 6
- * JERA Hirono Thermal Power Station Unit 5
- * Daicel Otake Factory Waste Acid / Waste Alkaline Treatment Furnace
- * Mie Central Development Industrial Waste
- * Kyushu Hokusei Industrial Waste Furnace
- * Ryoko Lime Industry Firing Furnace
- * Toyota Chemical Engineering Industrial Waste
- * Senshu Clean Center Industrial Waste
- * Noda Biopower (biomass power plant)
- * National Bioenergy KENLI Co. Ltd (China)
- and Many other plants.

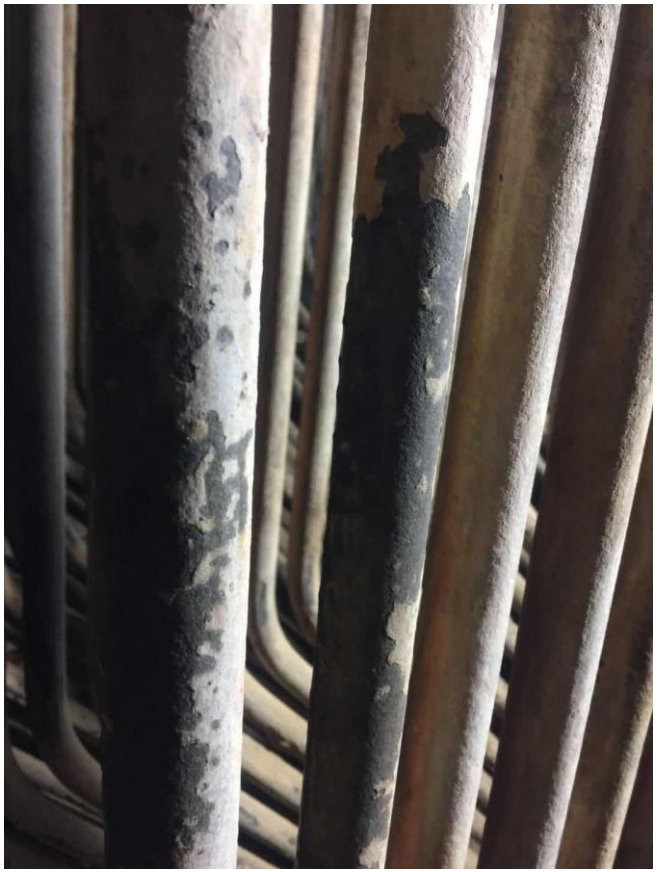
Biomass power plant screen tube clinker adhesion countermeasure example 6 months Cosmocoat coated / non-coated clinker adhesion status comparison

Cosmo coat coating part



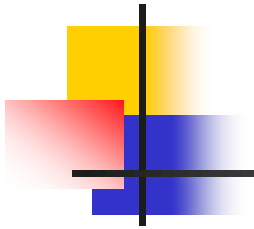
Cosmo coat non-coating part

Biomass boiler super heater construction example (steam temperature 510 ℃) Comparison of Cosmocoat coated and uncoated water pipes



Residual black cosmo coat film on water pipe (no water pipe thinning)

Water pipe corrosion thinning



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