SIMONA

Project Report 17

Flue Gas Desulphurisation with SIMONA® PP-H 100 AlphaPlus Pipes

Project Data

Project	Renewal of the Flue Gas Desulphurisation Plant (FGDP) at Niederaussem Power Station with blast lances made of SIMONA® PP-H 100 AlphaPlus
Requirements	Chemical and abrasive stress externally and internally Medium: HCl, SO_2, HF, milk of lime-gypsum suspension, pH 3–4 Solids content: approx. 12 %–15 % service pressure: approx. 0.5 bar Service temperature: approx. 70 °C
Client	RWE Energie AG, Niederaussem Power Station Installed power: 3864 MW in 9 blocks, lignite demand: 21.2 mill. t/a
General contractor	K & W Knäpper & Witt GmbH, Nordkirchen-Capelle
Subcontractor	ATEA GmbH, Ransbach-Baumbach
Plastic construction	KTW GmbH & Co. KG, Ransbach-Baumbach
Project management Assembly	ATEA GmbH, Ransbach-Baumbach
Technical support	Applications Technology Dept., SIMONA AG, 55606 Kirn
Connection systems	Heated tool butt welding in accordance with DVS 2207-11 Extrusion welding in accordance with DVS 2207-4 Hot-gas string bead welding in accordance with DVS 2207 Socket connections on site with lip seals
Products used	SIMONA® PP-H 100 AlphaPlus pipes, d 110 – d 500, SDR 11, length = 5 m SIMONA® PP-H 100 AlphaPlus fittings: tees, reducers, flanges SIMONA® PP-DWU sheets
Time	2004

SIMONA® PP-H AlphaPlus – a Cost-effective Solution for Flue Gas Desulphurisation Plants

Owing to the high load of combustion gases on the flue-gas desulphurisation plant in Niederaussem, RWE Energie AG decided on renovation. On account of corrosion the rubber-lined steel pipes generally have a service life of 5 to 8 years.

For this reason a search was conducted for material which would be able to replace the rubber-lined steel pipes previously used as blast lances. The new material would have to have a longer service life and ensure a high degree of operational reliability, and thus reduce running costs. Therefore RWE Energie AG decided in favour of SIMONA® PP-H 100 AlphaPlus – a material which meets all the criteria.

The flue gas desulphurisation plants (FGDP) remove acid and aggressive pollutants such as HCl, SO_2 and HF gases from the combustion gases of the power station using a pH-controlled scrubbing liquid. The scrubbing liquid for the flue gas desulphurisation plants consists of dissolved and undissolved lime as well as gypsum components which arise from chemical absorption of the lime with SO_2 pollutants. In lignite power stations the scrubbing liquid has a temperature approx. 70 °C and a pH between 3 and 4. Owing to the acid potential and the moist atmosphere at increased temperature steel components must be protected against corrosion very effectively. On account of the gypsum-milk of lime suspension the pipelines are also subjected to abrasion.

When the lignite power stations were upgraded with flue gas scrubbers in 1987 to 1988, various grades of soft rubber were used to line the scrubbing towers made of black steel and for the suspension-carrying pipes.

1: Flue gas desulphurisation plant in Niederaussem
2: Flue after repairs

The rubber linings have to be renewed every 5 to 8 years owing to the loads. This means considerable expenditure and increased down times. In searching for alternatives the main focus of attention was on operational reliability and longer service lives, in order to reduce running costs.

SIMONA® PP-H 100 AlphaPlus – an ideal structural material

When stainless steels, GRP (glass-fibre reinforced plastic) and modified GRP surfaces and SIMONA® PP-H 100 AlphaPlus had been examined for service capability in extensive tests, SIMONA® PP-H 100 AlphaPlus proved to be the most cost-effective material with the desirable longer service life. In addition, SIMONA® PP-H 100 AlphaPlus has excellent chemical resistance, a high level of physical stability of up to 100 °C, high abrasion resistance and reduced flow resistance.

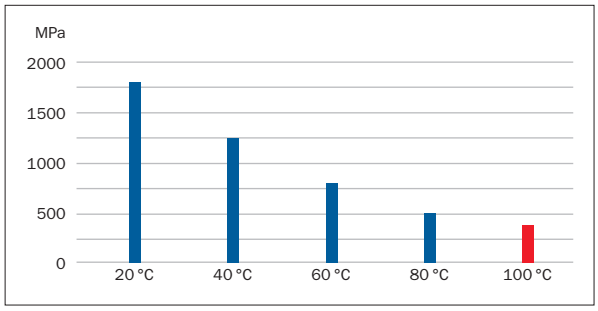

Fig. 1: Modulus of elasticity in traction of SIMONA® PP-H 100 AlphaPlus measured an a pressed sheet

The good mechanical properties also qualified SIMONA® PP-H 100 AlphaPlus as an ideal structural material. In a short-time tensile test high moduli of elasticity were measured up to a temperature of 100 °C (see Fig. 1).

The material SIMONA® PP-H 100 AlphaPlus has very good chemical resistance to organic and inorganic acids, alkalis and solvents up to temperatures of 100 °C. The media occurring in the absorption scrubbers, such as hydrochloric acid and sulphuric acid, have no influence on the service capability of SIMONA® PP-H 100 AlphaPlus for many years. That is why from a chemical aspect long service lives are to be expected. For many decades PP-H 100 has been successfully used in the chemical industry and in pickling and regenerating systems for precisely that reason. As a result, in many sectors PP-H 100 has replaced metal materials, which often have very short service lives owing to increased corrosion. SIMCHEM 5.0, our CD-ROM catalogue for chemical resistance offers detailed information on the corrosion resistance of SIMONA® products.

The high abrasion resistance of SIMONA® PP-H 100 AlphaPlus was demonstrated in various laboratory tests and practical experiments. For example, in a sand-slurry test the indoor wear of pipes was simulated and a high wear resistance was demonstrated in comparison with other materials. In addition, in a spray test, which simulates outdoor wear, the high wear resistance of PP-H 100 to erosion was measured by spraying the surface with an abrasive liquid (see Fig. 2).

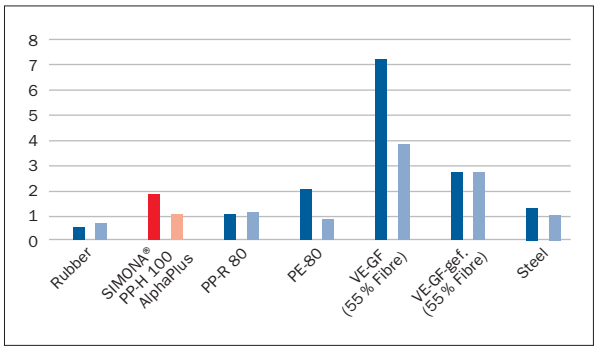

Fig. 2: ■ *Sand-slurry test (indoor wear)*
■ *Short-time spray test (outdoor wear)*

Advantages confirmed in empirical test

Suspension-carrying PP-H 100 liner pipes confirmed the excellent laboratory results in a two-year test at a power station. It was also demonstrated that owing to the use of plastic pipes a higher level of cost-effectiveness is achieved compared with rubber-lined steel pipes. Owing to the very low surface roughness R_a of SIMONA® PP-H 100 AlphaPlus pipes amounting to less than 0.4 µm the flow resistance, and hence pressure loss, is reduced by up to 10 per cent depending on the velocity of flow.

The actual starting position at Niederaussem lignite power station

The lignite power station operated by RWE Energie AG in Niederaussem has a capacity of 3864 MW. Of that figure 1,000 MW are generated at an efficiency of over 43 % in a plant (BoA I) which was commissioned in 2002. The old plants operate at an efficiency of more than 31 %.

The combustion flue gases are cleaned in special scrubbers using appropriate wet processes. Desulphurisation is performed using milk of lime, which is sprayed in a fine current of mist flowing counter to the flue gas. Tapered nozzles made of silicon carbide (SiC), which are attached to the branches of the blast lances, generate the spray. The reaction product occurring is gypsum, which, in the purity produced here, is ideal for the construction industry.

In Niederaussem the old flue gas desulphurisation plants had to be completely renovated owing to the long service life. Consequently, the steel scrubbers with a diameter of approx. 20 m and a height of approx. 40 m were relined inside and the blast pipes made of rubber-lined steel (St37) were completely replaced by SIMONA® PP-H 100 AlphaPlus blast pipes. The number of nozzle levels was reduced from five to four because this was acceptable in terms of process engineering.

3: Blast lance components made of SIMONA® PP-H 100 AlphaPlus
4: Extrusion welds on the branches for the nozzles
5: Lifting of a prefabricated nozzle lance
6: Assembled nozzle level


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Manufacturing the blast lances

The blast lances are made from pipes with graduated diameters. As a result, the nozzles can be subjected to virtually constant pressure over the entire length of the pipes. The largest diameter is 500 mm outside and the smallest diameter is 110 mm. Diameter is reduced in up to four stages.

The reducers and nozzle connection pipes are positioned below the lance so that complete emptying takes place on shutdown. In addition, the reducers are arranged off-centre so that flow resistance is reduced at the bottom and turbulence is avoided. The pipes and interconnecting sockets were connected to one another by heated tool butt welding (Fig. 4).

Welding of the branches to the main pipe was conducted by extrusion welding. The fixed flange and the pipe segments were also connected to one another by heated tool butt welding.

In order to absorb the heavy weight of the tapered nozzles amounting to about 7 kg a sheet 20 mm thick was welded between two opposite branches. This ensures that the nozzles always retain their position, even at a temperature of 70 °C. There have already been positive experiences with this design for several years. In order to increase service lives in the light of abrasion, all the welding flash and edge projections inside the pipes were removed or levelled. Consequently, turbulence behind the welding flash or edges is prevented, which might lead to increased erosion at a flow velocity of 2–3 m/s.

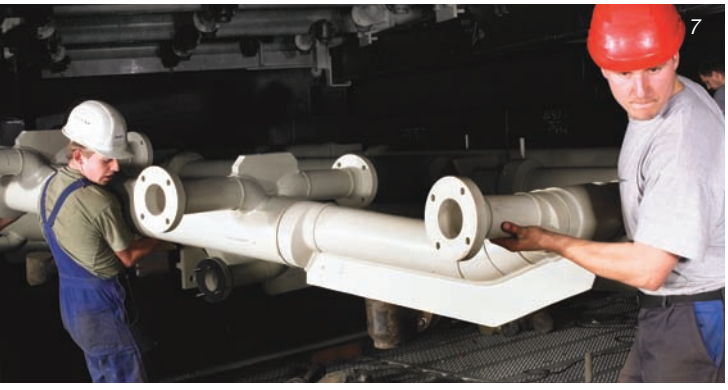
Assembly of the blast lances on site

The blast lance parts delivered were introduced to the tank through a manhole near the bottom. The nozzle levels above a height of 28 m were completely clad, with the exception of an opening through which the pipe parts were hoisted to the various working levels using a block and tackle.

The pipes were supported by the existing steel girders, which had been fitted at intervals of 2 m (Fig. 6). The pipes were sized so that the bowing of the pipes is negligible when exposed to a temperature of 70 °C and completely filled with a milk of lime-gypsum suspension. The pipes with a diameter of 500 mm were therefore sized with a wall thickness of > 45 mm. Where bowing was expected to be higher, axial reinforcements were provided.

The blast lances were firmly connected to the supply pipes by means of flange assemblies. They lie on steel girders and can move freely in an axial direction.

To support the pipes special channels were made using SIMONA® PP-DWU sheets, which were attached to the I-beams with PP bolts (Fig. 8). They ensure that the pipes can move in an axial direction. This movement is chiefly caused by thermal expansion, which is approximately twelve times greater than that of steel. At the ends of the blast pipes there are sliding bearings in order to prevent stresses and strains from building up on account of thermal expansion by the pipes.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The individual pipes prefabricated at the workshop were connected to one another using special interconnecting sockets. To make sure the socket connections remain tight even in the event of tensile loads and do not become detached during vibrations, they were secured with safety bolts to prevent axial forces (Fig. 9).

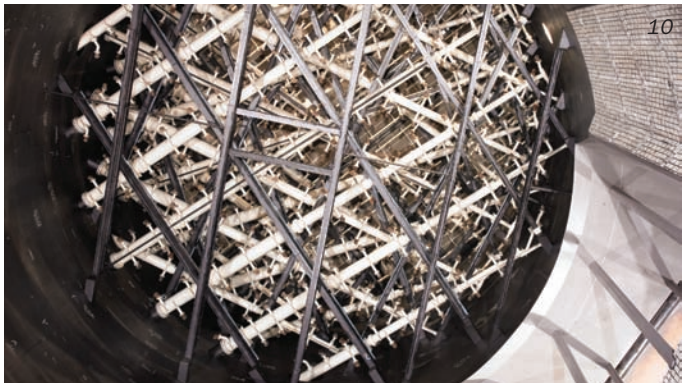
After an installation period of about two weeks all the scaffolding was removed. Then the mist collectors made of SIMONA® PP-DWU sheets were fitted above the nozzle levels. Finally, the scrubber was put into service again, so cleaned flue gases were able to leave the chimney again after only three weeks.

Literature

Dr. Boris Gibbesch:
Practical Experiences of Plastic Pipes in Flue Gas Desulphurisation Plants; specialist conference "Corrosion Protection in Flue Gas Desulphurisation Plants" in Essen, 1997

Dr. B. Gibbesch, M. Schütz, St. Müller:
Use of PP/GRP composite structures in suspension-carrying pipes of a flue gas desulphurisation plant, VGB Kraftwerkstechnik 6/98, P. 103–111

7: During installation of the pipes at one level: the various pipe segments were sized so that it would be possible to have them assembled by four persons
8: Channel support made of SIMONA® PP-DWU sheets
9: Sliding bearing at the end of the blast lance in order to absorb thermal expansion
10: View of the nozzle levels from below, revealing the size of the scrubbing towers



Range of Products

SIMONA AG is one of the leading manufacturers of thermoplastic semi-finished products in the world. Over 40 years of experience in formulation, production and processing qualify us as specialists with unique know-how. This experience and close contact with our customers ensure high-quality products and superior customised solutions.

Pipes, fittings, valves

Available ex stock

PP-H 100 AlphaPlus	polypropylene, homopolymer, grey RAL 7032

Pipes, fittings, valves	**PP-H 100 AlphaPlus**
Pressure pipes	■
Ventilation ducts	■
Fittings for IR/butt welding	■
Fittings for electrofusion welding	■
Special fittings	■
Fittings for flange assemblies	■
Valves	■

For production reasons individual sizes of injection-moulded fittings are also manufactured in PP-R 80.

Properties

- High impact resistance
- High chemical resistance (excellent in contact with many acids, alkalis and solvents)
- Maximum tension crack resistance
- Corrosion resistance
- Good hydraulic properties due to smooth interior pipe surfaces (no deposits)
- Physiological safety

Semi-finished Products

Standard articles	
PP-DWU	Homopolymer, permanent-heat resistant, grey
PP-DWU-SK	Homopolymer, permanent-heat resistant, grey, polyester-backed

Available on request	
PP-DWU-B	Homopolymer, permanent-heat resistant, grey, for tanks requiring mandatory test certificates
PP-DWU-GK	Homopolymer, permanent-heat resistant, grey, glass fibre-backed

Semi-finished products	PP-DWU	DWU-B	PP-DWU-SK	PP-DWU-GK
Extruded sheets	■	□	■	□
Pressed sheets	■	□		
Welding rods	■	□		
Solid rods	■	□		
Profiles				

■ Standard articles □ Available on request

Properties

- High chemical resistance (excellent in contact with many acids, alkalis and solvents)
- Permanent-heat resistance
- Corrosion resistance
- Excellent processing capability
- Physiological safety

For further information about application issues please contact our Applications Technology Department:
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Brochures and catalogues containing further information

- Semi-finished Products Catalogue
- Pipes and Fittings Brochure
- SIMPLAST 1.0
- SIMCAT 3.1
- SIMCHEM 3.0
- Semi-finished Products for Tank/Vessel Construction Brochure

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From the planning of your project through to pre-engineering in the field. Worldwide.

For you in the field of chemical apparatus and installation engineering this means:

- Advice concerning the chemical resistance of SIMONA® materials.
- Exposure tests in accordance with DIN 16888 Parts 1–2 and ISO 4433 Parts 1–4
- Appraisal of reduction factors by means of immersion tests or determination by internal pressure creep rupture strength tests
- Testing of the potential of a liquid for initiation of tension cracks
- Assessment of permeation during use in composite construction and in lining technology with an appropriate material recommendation

For tank/vessel construction we offer you the following services:

- Appraisals and verifiable structural analyses for rectangular tanks (perimeter reinforcements, cross-ribbed) and circular tanks in accordance with DVS 2205
- Design consulting
- Processing instructions
- Structural analyses of shafts
- Theoretical and practical training sessions

In the field of composite construction and lining we can advise you on:

- Lining technology
- Welding processes
- Selection of fabric material
- Gluing technique or selection of reaction resin
- Surface pretreatment
- Composite construction

Other services offered

- Training for your members of staff in the field or at our Technology Centre in Kirn
- Customised affixing of sheets

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We look forward to assisting you

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