SCHACK® PRODUCTS FOR THE CARBON BLACK INDUSTRY
1.1 THE COMPANY

SCHMIDTSCHE SCHACK was created by the amalgamation of the two traditional companies Schmidt'sche Heissdampf-Gesellschaft mbH, Kassel, and Rekuperator Schack KG, Düsseldorf.

SCHMIDTSCHE SCHACK is a solution provider in the field of process heat transfer and supplies relevant components for plants in the chemical, petrochemical, metallurgical and glass-smelting industries. Due to the broad experience gained in many different types of processes SCHMIDTSCHE SCHACK can make use of proven solutions and transfer such concepts to similar process requirements.

1.2 PRODUCTS AND SERVICES

Schack® products for the carbon black industry are integral process components for energy recovery and thereby serve to optimize the efficiency of the carbon black process and reduce cost.

Already in 1957 Rekuperator Schack, predecessor of SCHMIDTSCHE SCHACK | ARVOS GMBH, developed, fabricated and supplied its first air preheater for the carbon black industry. Since then continuous research and development on the air preheater and other Schack® products for the carbon black industry enabled SCHMIDTSCHE SCHACK to reach the position of a world leading supplier.

The exceptional technical understanding and know-how of the two founder companies form the main basis of today’s SCHMIDTSCHE SCHACK products and solutions.

SCHMIDTSCHE SCHACK, Düsseldorf, is leading in high-temperature technology. The proven competence stems from experience gained since 1931 in the fields of recuperators for industrial high-temperature application, steam superheaters and fired heaters for process media.

1.3 CARBON BLACK

Technical carbon black is produced by subjecting hydrocarbon feedstock to extremely high temperatures in a carefully controlled combustion process. Carbon black is used as a high performance reinforcing component in technical rubber products and as a color pigment. It is a quality determining component and defines the characteristics of the final product.

In the predominant fabrication process – the furnace carbon black process – carbon black is produced when heavy residual oil feedstock is injected into the hot zone of a flame, in excess of stoichiometric quantities.

Rapid cooling by water quenching to approx. 1,500 °C stops the carbon black formation process and defines particle shape, size and quality.

The heat contained in the mixture of process gas and carbon black can be returned to the process by means of heat exchangers or can be used externally by a waste heat boiler to generate steam. After separation of the carbon black a combustible waste gas remains. Incineration of this tailgas in a combustion chamber enables the recovery of energy for the use in carbon black dryers or for steam generation.

The Schack® Air Preheater and the Oil Preheater convey heat from the process gas directly back to the reactor, thus fuel is saved and the yield of the carbon black process is increased.

Schack® Quench Boilers and Reactor Boilers generate steam for turbine drives and external use. Schack® Tailgas fired Boilers also produce steam for turbine drive and power generation. Schack® Rotary Dryers dry the carbon black pellets by using the heat from combustion chambers using carbon black process’ tailgas as a fuel.
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Figure 1: Schack® APH 800/144, APH 800/80 and APH 900/144 at the SCHMIDTSCHE SCHACK workshops in Kassel

Figure 2: Schack® APH 800/108 and 900/90 under erection

Figure 3: Schack® products in carbon black processes
3.1 SCHACK® AIR PREHEATER

For the carbon black process Schack® Air Preheaters (APH) are designed according to the principle “flue gas through the tubes”. The combustion air in the APH shell is directed around the tubes by means of baffles.

Most Schack® Air Preheater types have externally cooled inlet tubesheets (double bottom tubesheets – DBTS). The cooling air for the DBTS is branched off from the process air flow and directly conducted to the DBTS. In the APH the cooling air is returned into the process air flow. An external cooling air discharge is not necessary.

Schack® APHs are of standardized design. They are selected according to the requested process parameters.

SCHMIDTSCHE SCHACK’s continuous R&D endeavours to further increase product and plant efficiency led to gradual raising of the air preheating temperature exceeding 930 °C. In parallel design details were optimized and material selected and tested to meet increased operation parameters. Advanced calculation and computer simulation methods combined with data gained from customer feedback from hundreds of APHs in service in carbon black plants around the world made this possible. For all steps in design, dimensioning, fabrication and inspection the strict Schack® quality standards are applied.

Schack® APHs have self-supporting shells. Therefore a support of the shell by spring hangers and a support structure are not required.

3.2 ACCESSORIES

APHs for carbon black processes are complemented by Schack® accessories. The inlet box serves for approach flow of the APH with carbon black gas and supports the APH. Downstream of the APH, the outlet cone and the return bend form the connection to the carbon black plant.

To compensate the thermal expansions between APH and carbon black gas ducting SCHMIDTSCHE SCHACK has developed a special type of expansion joint. Thanks to the shape of the Schack® Saw Tooth Expansion Joint blocking by product deposits is efficiently avoided. Additionally SCHMIDTSCHE SCHACK offers tube cleaning systems for APHs which clean the tubes by means of steam pulses during operation.
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Figure 6: Air preheating increases profitability of carbon black process
Figure 4: SCHACK® APH with internal cooling air discharge
Figure 5: SCHACK® APH in hard black and soft black lines
Figure 8: FEM analysis of APH inlet tubesheet (DBTS)
Figure 7: Load range of APH types

<table>
<thead>
<tr>
<th>Process air</th>
<th>Hot air to reactor</th>
<th>DBTS cooling air</th>
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<tr>
<td>Air preheaters in the furnace carbon black process preheat combustion air for the reactors. Process gas heat is regained and provides positive effects to the operation cost by</td>
<td></td>
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<tr>
<td>• reduction in fuel consumption</td>
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<tr>
<td>• increase in feedstock flow</td>
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<tr>
<td>• rise in carbon black production yield</td>
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<tr>
<td>• reduction in quench water consumption</td>
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<tr>
<td>Increased air preheating temperature supports these positive effects and also reduces CO2 emissions of the process.</td>
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The tailgas generated during the carbon black production has a significant energy content due to its high proportion of combustible elements. For environmental reasons the gas has to be treated in a thermal oxidizer process to minimize the quantity of hazardous substances. It is profitable to make use of this thermal energy to produce steam or electricity.

SCHMIDTSCHE SCHACK’s experience in combustion of CO gas combined with sophisticated examination methods permit optimization of the equipment, observing all requirements regarding CO and NOx emissions. Furthermore by energy recovery in the Schack® Tailgas Boiler, a reduction in overall CO2 emissions of the carbon black plant is achieved as well. The specific conditions of the carbon black factory as well as environmental regulations are considered and are complied with by SCHMIDTSCHE SCHACK.

4.1 SCHACK® TAILGAS BOILER

Schack® Tailgas Boilers have proven themselves in practice in the carbon black industry all over the globe. Combined with Schack® Tailgas Combustion a system results which particularly meets the high requirements of the carbon black industry in terms of availability, maintainability, efficiency and environmental protection.

Advanced tailgas boilers are of modular designs, taking into account individual requirements. The basis is the Schack® Combustion Chamber and the Heat Recovery Boiler.

The tailgas boiler can be additionally equipped with:
- Tailgas booster fan
- Multi fuel auxiliary burner
- SNCR reaction zone
- Induced draught fan
- Stack

Depending on the required steam parameters tailgas boilers are available in fire tube or water tube design.

Besides the boilers SCHMIDTSCHE SCHACK supplies all auxiliary equipment required for boiler plants.

The scope of supply provided by SCHMIDTSCHE SCHACK is not limited to hardware supply – it also comprises services. Erection, supervision, commissioning, maintenance and repair as well as training of operator personnel are available to customers around the world.
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![Figure 14: CFD modelling of tailgas combustion chambers](image)

![Figure 15: Inside view of a combustion chamber in operation](image)

![Figure 16: Modular Schack\textsuperscript{®} Tailgas Boiler](image)

![Figure 17: Available steam capacity and electrical power for typical steam parameters of a tailgas boiler](image)

![Figure 18: Typical tailgas boiler arrangement](image)

![Figure 19: Partial view of a tailgas combustion chamber during erection](image)

![Figure 20: Schack\textsuperscript{®} Tailgas Boiler with 49 t/h steam capacity](image)

![Figure 21: Schack\textsuperscript{®} Tailgas Boiler for 75,000 Nm\textsuperscript{3}/h tailgas during erection on site](image)

![Figure 22: Auxiliary burner for natural gas with instruments](image)

![Figure 23: Tailgas boiler for 41 t/h steam at 45 bar / 400 °C](image)
In addition to the air preheaters quench boilers, reactor boilers and oil preheaters are integrated in the carbon black process. Also these Schack® products serve to recover energy.

The carbon black gas cooling by energy recovery saves quench water, which otherwise would be used to reduce the gas temperature before entering the process filter. As less moisture is contained in the carbon black gas the volume flow to the process filter is reduced. This results in lower pressure drop, reduced energy cost for the blower and longer service life of filter bags.

5.1 SCHACK® REACTOR BOILER

The Schack® Reactor Boiler in the carbon black process is a waste heat boiler that generates process steam. Carbon black gas is typically cooled down from 600 °C to 400 °C.

The reactor boiler is based on the principle of the shell-and-tube boiler where the flue gas passes through the tubes and the steam space is integrated in the shell. Design and process data are harmonized so that there is no tendency to fouling which would affect the operation.

References prove the high reliability of Schack® Reactor Boilers in service for many years.

5.2 SCHACK® OIL PREHEATER

Schack® Oil Preheaters recover the energy from the carbon black gas to preheat the feedstock.

They are designed as tube coils and arranged in the flue gas duct downstream of the air preheaters. Steam superheaters can be designed in the same way offering a solution for steam drying and moderate superheating.

5.3 SCHACK® QUENCH BOILER

Schack® Quench Boilers are positioned within the carbon black process directly downstream of the process quench of the carbon black reactor. Typically, at an inlet temperature of 1,400 °C and above they cool the carbon black gas to e.g. 3,000 °C.

The cooling temperature window is adjusted to the inlet temperatures of the air preheater connected downstream.

When the process air preheating temperature is to be less than 800 °C, quench boiler outlet temperatures below 1,000 °C can be achieved by installing quench boilers with longer dimensions. Thus, higher steam generation in the quench boiler is obtained.

The heat recovered from the carbon black gas is used by the Schack® Quench Boiler to generate saturated steam. The boiler operates in natural circulation mode. Due to the unique double tube design quench boilers are resistant against extremely high thermal loads.

In service the Schack® Quench Boiler has shown only very low tendency to fouling and proven outstanding reliability.
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6.1 SCHACK® ROTARY DRYER

Besides the described thermal systems SCHMIDTSCHE SCHACK also provides Schack® Rotary Dryers, an important link in the chain of process components of a carbon black production plant.

SCHMIDTSCHE SCHACK's experience in the field of drum-type dryers is based on Rekuperator Schack know-how and complemented by the experience of Raymond Bartlett Snow division of the ARVOS Group.

Schack Rotary Dryers improve the energy efficiency of carbon black manufacturing. Their combustion chambers allow carbon black tailgas, characterized by a low caloric value, to be used as a fuel without supplementary firing.

Figure 31: Rotary dryer, 3' diameter, 80' long, during fabrication in the shop

Figure 32: Rotary dryer with accessories: gate valve, pelletizer and screw feeder

Figure 33: Inside view of a 9' dryer drum

Figure 34: Rotary dryer during erection on site

Figure 35: Lower section of furnace shell for a 10' Schack® Rotary Dryer

7.1 EXCELLENCE IN DESIGN, RESEARCH & DEVELOPMENT

SCHMIDTSCHE SCHACK's activities in the field of heat recovery equipment and boiler engineering require a very broad engineering knowledge. Relying on the latest computer technology and refined engineering software systems, our R&D department analyzes and solves a wide range of very intricate tasks related to process and boiler dynamics, non-linear mechanics, vibration theory, thermodynamics, etc.

From the combination of experimental results and theoretical investigations, new designs and solutions to specific engineering challenges are developed.

Figure 36: Main office and workshops in Kassel, Germany

7.2 EXCELLENCE IN MANUFACTURE

In order to meet our customers’ quality requirements as well as our own stringent standards, we are committed to running our own production facilities in Kassel, Germany. This constitutes the link between our excellence in design, research & development, and our customers’ expectations in terms of the outstanding performance of our products.

The latest manufacturing techniques, sophisticated production and testing machinery combined with highly qualified, annually certified manufacturing personnel, ensure the creation of top-quality products.

SCHMIDTSCHE SCHACK performs NDT with its own personnel and equipment in accordance with EN 473 and SNT-TC-1A, level II and III for the procedures of RT, UT, MT, PT, VT and LT.

7.3 EXCELLENCE IN QUALITY MANAGEMENT

Quality management in our opinion means more than simply complying with standards and meeting the demanding requirements of our customers.

SCHMIDTSCHE SCHACK is certified according to ISO 9001, ASME U, U2, S, PP, R-Stamp, Safety Quality License for Import Boiler and Pressure Vessels to the People’s Republic of China, Korean Manufacturing License, ISO 14001; OHSAS 18001; “Großer Eignungsnachweis” according to EN 1090-2; DIN EN ISO 3834-2; AD2000 – HPO, PED 97/23/ EG Module H+H1 and other national and international standards.

Excellence in SCHMIDTSCHE SCHACK’s quality management again is documented by the safety management SCC certificate.
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