

COKE-OVEN GAS PROCESSING EQUIPMENT

 **ZVU** Engineering a.s., Member of ZVU Group

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1 INTRODUCTION

On producing coke by coking coal in batteries, by-products are generated and taken away from batteries in coke-oven gas (COG). Subsequently, COG is processed in by-product units, products of which are treated COG and recovered technical by-products, such as ammonia (further processed to ammonia sulfate), benzole, and tar.

By-products recovery is usually linked up with economic and environmental aspects of their production and utilization.

By-product technologies have been investigated and verified largely in details. Therefore, a substantial role how to ensure proper technological function is played by selection and arrangement of individual apparatuses.

ZVU Engineering belongs among important and recognized suppliers of critical apparatuses for coke-oven gas processing plant (by-product plant). Acting as a member of ZVU group, ZVU Engineering has designed, delivered, installed, and commissioned the selected apparatuses and operating units in most Czech and Slovak coking plants, and participated in many domestic and foreign projects of coke-oven gas processing branch.

Tradition of many years at delivery of this commodity and vast know-how in the field allow our specialists to design and implement modern apparatuses in compliance with specific process requirements of customers.

Apparatuses designed by ZVU Engineering permanently feature verified construction elements and sub-assemblies which principally influence effectiveness, safety, and trouble-proof operation.

2 CONCEPTION OF APPARATUSES

To satisfy needs of the Czech and Slovak coking plants, ZVU Engineering has developed critical apparatuses that significantly influence economy and stability of coking plant operation. Since 1990 gradually, ZVU Engineering has installed and put into operation modernized apparatuses of coke-oven gas processing plant in coking plants Svoboda, Šverma, Třinec, and Košice.

On designing, ZVU Engineering devotes meaningful attention to sub-assemblies of apparatuses which are critical from standpoint of both operation and maintenance. It concerns before all the measures aimed to corrosion protection, operation leakage avoidance, and exclusion of deposits and clogging by accompanying components contained in working media, etc.

Actual size and arrangement of apparatuses is determined individually, based on the specified inlet and outlet process parameters.

Optimizing apparatus design results always in saving both investment expenses and operation costs.

2.1 Primary Cooler

Primary cooler is linked up at the very inlet of coke-oven gas (COG) to by-product plant, and provides COG primary cooling and condensation of predominant part of entrained components, such as water, tar, and naphthalene.

Primary cooler consists of horizontal tube bundle sections interconnected in series (or more circuits as well) which are flown through with water having temperature about 25 °C, thus indirectly cooling down coke-oven gas from temperature about 80 °C to about 50 °C.

Primary cooler body is usually fabricated of carbon steel, while heat exchange tubes are hot dip galvanized or made optionally of stainless steel.

Design solutions of primary coolers allow for cleaning inner surface of cooling tubes. Arrangement of cooling tubes makes possible to reach higher turbulence in gas flow and higher heat transfer coefficient.



Fig.1 Primary Coolers in Coke-Oven Plant Svoboda, Ostrava

As an example of primary cooler, the apparatus for processing 30 000 m³/hr COG can be mentioned, having ground view area 3.2 x 3.8 m, height 22 m and heat exchange area 3 700 m², installed in coking plant TŽ Třinec.

2.2 Final Cooler

Final cooler is connected at the COG outlet from by-product plant after COG desulphurization and ammonia recovery units, and serves for COG final cooling and washing naphthalene remainders. This advantageous arrangement can provide both COG final cooling and pre-treatment.

Final cooler consists of two sections, namely the section for cooling COG by direct water spraying, and the section for liquid particles separation.

As an example of final cooler, the apparatus of output 45 000 m³/hr COG can be mentioned, having diameter 5 m and height 28 m, installed in coking plant Svoboda.

2.3 Tar Sludge Rough Separator

Tar sludge rough separator is connected at the inlet to tag sludge processing unit in by-product plant and serves for separation of rough tar sludge and solid particles from tar condensates.

Tar sludge rough separator is characterized by its rectangular retention tank where rough tar sludge is settled gradually. Tar sludge and other sediments are discharged from separator by means of robust rake conveyor.

Separator is usually made of carbon steel.

ZVU Engineering increasingly takes care of separator drive unit, and it's fitting with suitable gearbox system.

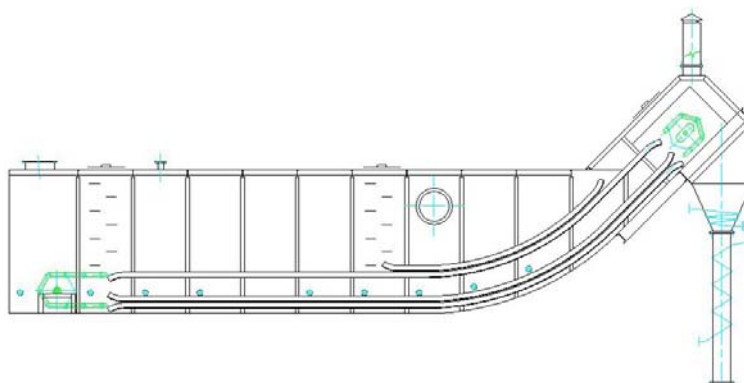


Fig. 2 Tar Sludge Rough Separator

As an example of tar sludge rough separator, the apparatus for processing 180 t/hr tar condensates can be mentioned, having outline dimensions 3 x 2.9 x 17 m and weigh 35 t, installed in coking plant Jan Šverma.



Fig. 3 Tar Sludge Rough Separator, KB9, Coking Plant, Svoboda, Ostrava

2.4 Tar Condensate Separator

Tar condensate separator is connected in the flow of tar condensates in by-product plant, and serves for tar condensate separation to tar and ammonia water.

Tar condensate separator is designed as a large volume vertical cylindrical tank, furnished with cone bottom and equipment for automatic discharge of separated phases.

Separator is usually made of carbon steel.

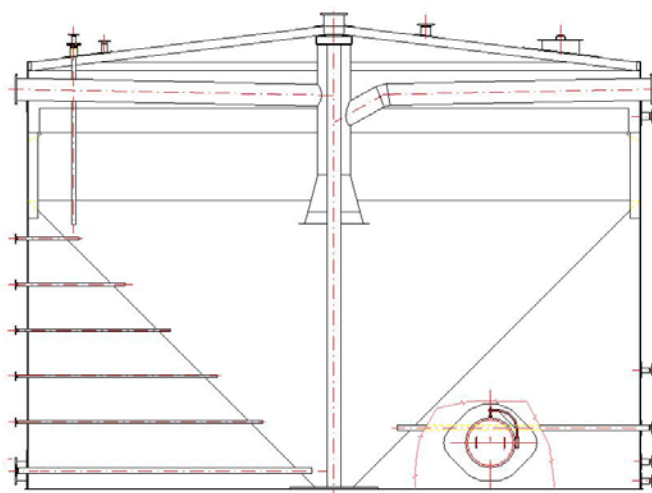


Fig. 4 Tar Condensate Separator

As an example of tar condensate separator, the apparatus for processing 180 t/hr tar condensates can be mentioned, having diameter 15 m and height 12, installed in coking plant Jan Šverma



Fig. 5 Tar Condensate Separator

2.5 Benzole Stripper

Benzole stripper serves for recovering benzole from washing oil. Benzole hydrocarbons are boiled out from washing oil, using direct stripping steam.

Benzole stripper is a column type apparatus, furnished with trays of various design to separate benzole vapours from washing oil liquid phase, using stripping steam.

Apparatus is usually made of combination of carbon steel and stainless steel.

As an example of benzole stripper, the apparatus of output 80 m³/hr washing oil can be mentioned, having diameter 1.4 m and height 13.2 m, installed in coking plant TŽ Třinec (see Fig. 8).

2.6 Sealing System

ZVU Engineering in cooperation with company ByPro Engineering, USA implemented the sealing system, purpose of which is to eliminate emissions of benzene, naphthalene and other compounds from apparatuses of coking plant in surrounding atmosphere, thus fulfilling environmental limits stipulated by national and regional regulations.

Sealing system consists of several independent collecting loops in which the transportation of vapors is ensured by sealing gas (clean coke-oven gas or nitrogen)

with a specified pressure difference along the whole length of the collecting loops. All vessels, tanks, sealing closures, pits, venting device and slops are hermetically sealed, while the escaping vapors are routed in the closed loop of sealing system collector.

By this arrangement, predominant part of emissions of benzene and naphthalene is trapped and subsequently liquidated by combustion together with coke-oven gas to heat up coking batteries, or in a power plant to generate electricity.

Sealing system is suitable with regard to environment, and its operation and maintenance are not demanding. Provided a simple and regular maintenance is carried out, the system is able to operate in a trouble-proof way for a long time.

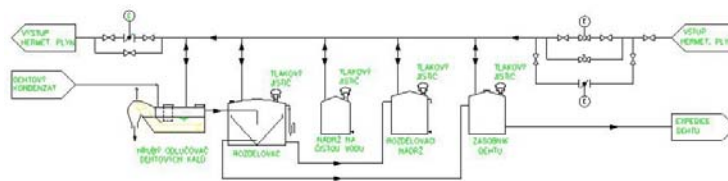


Fig. 6 Sealing System

The equipment installed to the existing apparatuses of coking plant Svoboda can be mentioned as an example of sealing system.



Fig. 7 Parts of Sealing System

3 FABRICATION, ERECTION AND OPERATION

3.1 Fabrication

All apparatuses are fabricated under strict supervision of ZVU Engineering quality inspector. Quality control of fabricated parts is continuously inspected in accordance with the verified and approved quality control plan.

Special attention is devoted to procedures and construction parts that have significant impact on reliability and lifetime of apparatuses, such as material quality and identification, quality of weld joints, tightness of apparatus joints, etc.

Fabrication is normally concluded by leakage tests and pressure tests eventually, witnessed by user's representative.



Fig. 8 Fabrication of Benzole Stripper for TŽ Třinec

3.2 Erection

Depending on outline dimensions, apparatuses are delivered in completely assembled state, allowing direct resting on foundations. Equipment erection is rather simple and the user has at disposal detailed erection instruction.

Equipment of greater dimension has to be delivered in divided execution due to transportation and handling reasons. Its erection may be relatively more demanding, therefore, ZVU Engineering supervisor/engineer on site is recommended.

Depending on user's wish, ZVU Engineering is ready to deliver apparatuses on the basis of turn-key projects.



Fig. 9 Erection of Benzole Stripper in Coking Plant Svoboda, Ostrava

3.3 Operation

Erection over, functioning and operation tests shall be carried out under presence of ZVU Engineering specialist.

Depending on user's wish, ZVU Engineering is ready to perform guarantee and output tests to monitor and evaluate all important process and technological parameters, thus proving apparatuses quality.

4 SERVICE, MODERNIZATION

4.1 After Guarantee Service

ZVU Engineering's apparatuses have been designed and fabricated to guarantee their lifetime maximum.

As long as the operating parameters specified by ZVU Engineering are kept, no special maintenance is required.

However, ZVU Engineering recommends checking periodically tightness of joints having impact on apparatus operation.

ZVU Engineering offers to perform regular inspections, including replacement of damaged parts.

4.2 Modernization

Although apparatuses are designed to withstand operation lifetime for 15 years at least, it is obvious technical progress and innovation trends run more quickly.

Based on its own development, ZVU Engineering performs periodical innovation of apparatuses in such a way so that their design and concept could comply with contemporary trends of modern technique.

Users of apparatuses of by-product units are recommended to keep permanent contact with ZVU Engineering, and through that procedure obtain continuous information on current design improvements, and operation of their apparatuses.