

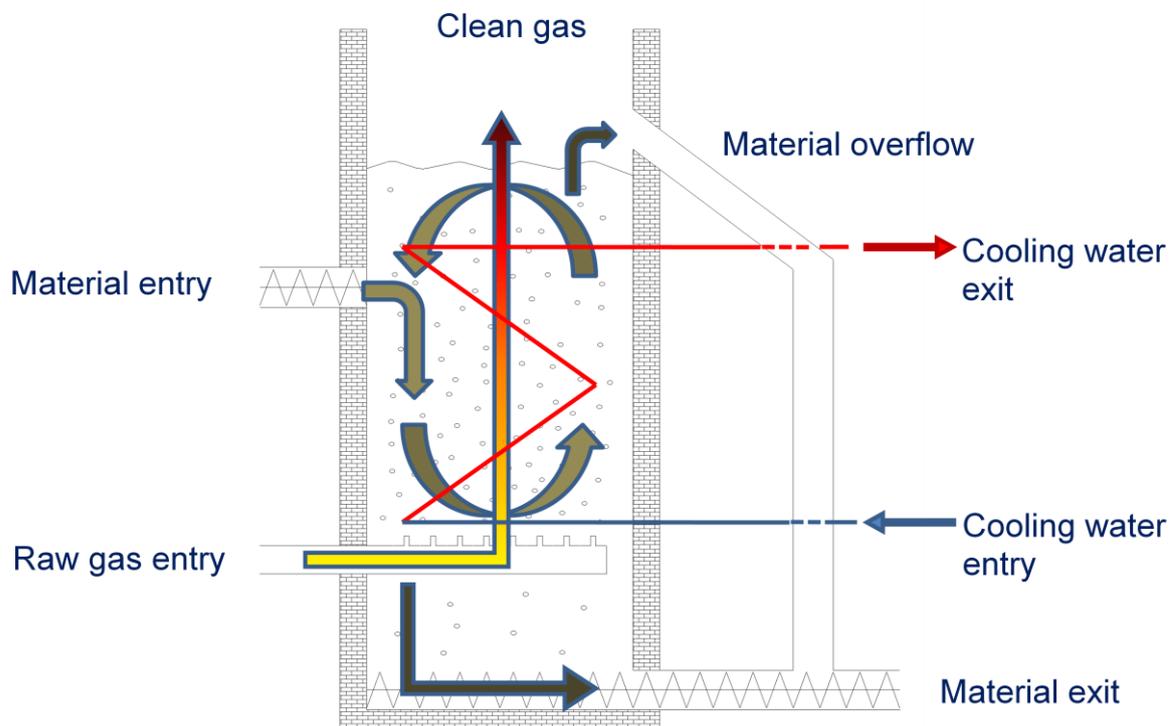
PROCESS- AND TECHNOLOGY- DESCRIPTION

**FLUIDIZED BED COOLING
OF
FUEL GASES**

Fluidized bed cooling of fuel gases

The company VER Verfahreningenieure GmbH (process engineers Ltd.) is already developing since 2007 a method for fuel gas cleaning with a fluidized bed cooler (WSK).

The WSK technology is used for rapid cooling of the fuel gas after the gasifier or directly to a combustion chamber. This is the cooling of gases with temperatures above 700°C to 100-150°C. This technology for gas purification can be used for diverse methods and different materials.



Picture A: process description of a fluidized bed cooler

Process description:

The raw gas flows from the bottom of the WSK apparatus and passes a nozzles floor and/or a different type of raw gas distributor chamber. This gas distribution chamber causes a uniform inflow of the fluidized bed apparatus and thus the fluidized bed.

Fluidized beds are characterized on the basis of the nearly ideal mixing of the fluidized material in WS-apparatus by a nearly isothermal behavior of the bed material.

In the reactor there is a cooling coil, which flows around the fluidized bed. The cooling coil is supplied as a water-glycol mixture from about 100 degree. As a cooling medium can also in the cooling register in boiling water for cooling water or thermal oil are used.

The main task of the fluidized bed cooler is the cooling of raw gas (the principle of dry gas masher) while simultaneously condensing organic gas components (e.g. tars from wood gas) from the raw gas to the fluidized bed-material. In order to avoid undue loading of the bed material, the fluidized bed continuously unloads bed material in the form of coke or similar material is fed via an entry lock at the reactor head. The bed material is loaded simultaneously discharged through an adjustable lower solid entry from the fluidized bed apparatus.

Alternatively, the lower solids may be withdrawn by a material overflow (upper discharge) also spent bed material to the system, takes place simultaneously by means of the upper fluidized bed, the automatic control of the filling level discharge in the fluidized bed apparatus.



Picture B: Overview on the planned and constructed WSK-plants by VER GmbH until today

Fluidized bed cooler, WSK 1

The first WSK system is based on the development by VER GmbH in 2007 as a pilot plant for the Technical University of Dresden, in the framework of the project: „Studies on the interfaces between biological and thermo chemical biomass gasification“, for fuel gas cleaning for a wood gasification planned and built.

Mr. R. Roscher has studied for his diploma work on this technology and cost-effective fuel gas cleaning for biomass gasification of small and medium power stage.

With the WSK 1 could be cleaned up to 50 Nm³ raw gas per hour in the experimental investigations.



Picture C: fluidized bed cooler, WSK 1

Fluidized bed cooler, WSK 2

DEUSA International GmbH is a long traditional company of salt mining with headquarters in Thuringia and is owner of a gasification plant for producing fuel gas from plastic gasification.

This system was tested under different experimental campaign. It was found that an effective gas cleaning is required so that the generated fuel gas to a further use may be supplied.

The VER GmbH was commissioned in mid 2008 with studies on the thermolysis reactor DEUSA International Ltd., through its attempt to provide technology to demonstrate an effective gas cleaning.

In just 3 months the VER GmbH realized the construction of the complex experimental system and was thus the beginning of 2009 the first successful experiments carried out in Thuringia directly on the gasification plant.

The WSK 2- fuel gas cleaning system consists of a fluidized bed cooler, a dust filter, an activated carbon filter and a HCL-gas scrubbing column.

With the WSK 2 gas cleaning can be a flow of 150 Nm³/h are cleaned continuously, up to date, further trials and applications with the WSK 2 system are prepared.



Picture D: fluidized bed cooler, WSK 2

Fluidized bed cooler, WSK 3

As part of the work in the VER Ltd., the CombiPower-process for fluidized bed gasification with downstream gas cleaning and gas use was developed. A key component of this multi-stage fluidized bed gasification technology, is the technology described above WSK.

The required proof of the procedure was performed for the CombiPower-process including in connection with the tests in the test field of the firm IFF Magdeburg in February 2010.

It could be shown that by using the IFF fluidized bed gasifier from wood produced raw gas was cleaned of 8-10 g / Nm³ tar and dust to less than 10 mg / Nm³ tar and dust.

As a result of this work, the Fraunhofer Institute in Magdeburg, appointed for a corresponding client project, after an international tender, the VER GmbH in December 2010, a fuel gas cleaning system after the WSK process for 600 Nm³ / h. The WSK 3 plant was built in 2011 and it is planned to invest in 2012, together with project partners in the process combination fluidized bed gasification of wood with a downstream fluidized bed gas cleaning, on site in Magdeburg to be tested.



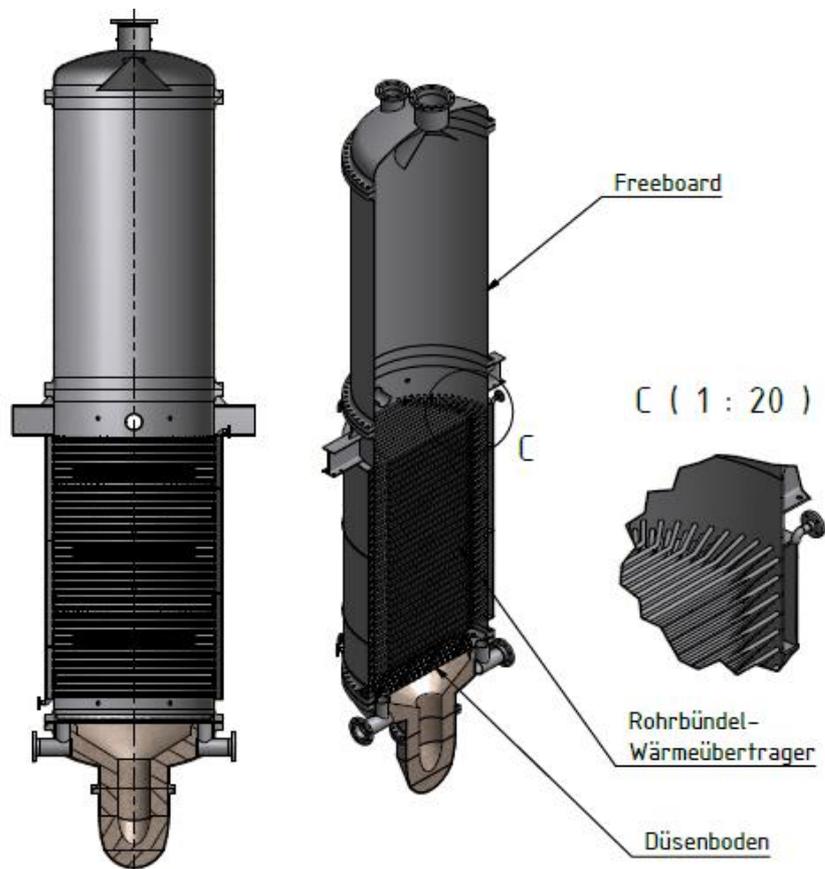
Picture E: fluidized bed cooler, WSK 3

Fluidized bed cooler, WSK 4

Since March 2011, the DEUSA International Ltd. got an approval notice for modification and expansion of its high calorific gasification plant for plastic waste at the site in Bleicherode, after the 17th BImSchG regulation.

For these gasifier is also a fuel gas cleaning system with major component of fluidized bed cooler (WSK), dust filter, gas after cooler, HCL-scrubber and activated carbon filter according to the VER process for gas cleaning is used.

After successful testing of the experimental pilot plant complex WSK-2 now is the implementation of the gas purification process, according to the customer request, a WSK system with a projected gas flow rate of several thousand Nm³/h.



Picture F: fluidized bed cooler, WSK 4

Stage of work: February 2012