The WTA technology
An advanced method of processing and drying lignite
With all our power – RWE Power

Energy is life. It is the nervous system of modern industrial society. We, the electricity producers in the RWE Group, do our considerable bit to ensure that the wheels don’t stand still. We produce electricity and heat, and we extract coal – on a secure, economically efficient, and environmentally sound basis. We are a global player today. Our roots lie by the Rhine and Ruhr rivers. We have traditionally had close links with the locations where we operate. That is because we have grown with the regions – and the regions with us.

Our commitment rests on this identity. Here, we are talking more than just electricity and heat. As important employers and investors, we underpin economic growth and jobs. In numerous projects and in close partnership with the regions, we support the residents and the economy at our locations.

We assume responsibility for things big and small. So we are just as committed to the environment “on our doorstep” as we are to global climate protection. Being Germany’s biggest electricity producer, we are proactively involved in designing concepts for the energy supply of the future. Our aim: to square the triangle of economic efficiency, security of supplies, and environmental compatibility.

We provide impetus – with our know-how, innovative technologies, and substantial investment in ultra-modern power plants. We are continuously working on making power generation even more efficient, while seeking solutions to the worldwide problem of a rise in energy needs and the growing scarcity of raw materials.

We combine all energy sources under one roof: from renewables like hydropower, wind and solar energy, via coal and gas, all the way to nuclear energy. With this balanced mix, we can create the best basis for long-term energy security. A workforce of 17,000 employees inside and outside Germany is committed to ensuring energy supply in Germany and Europe. With all their power.

The importance of drying in lignite processing

All industrial uses of lignite require upstream fuel drying. Owing to the high amount of water to be removed, lignite drying is a process that needs a lot of energy. This is why energy efficiency is of great significance here.

In conventional lignite-fired power plants, lignite is dried by hot flue gases which are recirculated from the steam generator furnace at temperatures between 900 and 1,000°C. Decoupling of the combined mild drying process applied so far allows drying at low temperature levels in an energetically more efficient way and, hence, helps to achieve a substantial increase in overall power plant process efficiency.

When power is generated in an integrated coal gasification combined-cycle power plant or in an oxyfuel process, lignite predrying is needed as a matter of principle. Here too, an energetically efficient drying process can contribute to further efficiency enhancement.

For so-called low-rank coals, which are not only characterized by high moisture contents but also have high ash contents, the calorific value can be raised by predrying to such an extent that these coals can be used for combustion in conventional steam generators without needing back-up fuels.
To allow lignite to be processed into gaseous and liquid products as well as high-grade solid fuels, its moisture content must be reduced to 10 to 20 % wt – depending on the production goal. Being a basic operation, drying plays a key role in the overall coal upgrading process as well. An energetically efficient drying process improves the energy balance of the overall process.

As an advanced method for processing and drying lignite, the WTA technology (WTA = German abbreviation standing for fluidized-bed drying with internal waste heat utilization) can be employed in all of the above processes and adjusted to the specific requirements in each case. It contributes significantly to optimizing the energy efficiency and reducing the emissions of the overall coal use process.

As the energy amount required for drying increases with rising moisture contents, the efficiency enhancement that can be achieved by the WTA technology in the power plant process is not a constant value, but a function of the moisture content: The higher the amount of water to be removed by drying, the greater the net calorific value-based efficiency enhancement potential that can be obtained by the WTA technology. The flue gas emissions associated with power generation (incl. CO2, SO2, NOx) are directly proportional to the fuel input or proportional to the power plant’s efficiency. The efficiency enhancement achieved through the WTA technology thus makes a direct contribution to reducing emissions and further improving the environmental compatibility of power generation. Fig. 1 illustrates by way of example for Rhenish lignite the emission reduction potential as a function of efficiency enhancement.

The WTA technology is based on the principle of a stationary fluidized bed with low expansion. The energy required for drying is supplied via heat exchangers that are integrated in the fluidized-bed drier and heated with steam. Drying takes place in quasi 100% pure steam which is slightly superheated. At constant pressure, equilibrium is reached – depending on the steam temperature – between the steam temperature and the residual moisture of the dried lignite. Fig. 2 shows this dependence for Rhenish and Australian lignite at a system pressure of approx. 1.1 bar. For a temperature of approx. 110° C (Rhenish) and of approx. 107° C (Australian lignite), a residual moisture content of some 12 % is reached. By controlling the fluidized-bed temperature, the moisture content can be adjusted and maintained constant at the desired value.

Fig. 1: Specific CO2 emissions as a function of efficiency

Fig. 2: Steam-coal equilibrium
WTA technology

Both variants can be integrated into the WTA process and allow the energy efficiency of the drying process to be further improved and emissions to be reduced. The produced vapour condensate can be used as water in industrial processes. The selection of the vapour utilization variant depends, among other things, on the drying task and the integration into the overall process.

**Variants of energetic vapour utilization**
Compared with other processes, lignite drying in a steam atmosphere has the advantage, among others, that the evaporated coal water can be condensed isothermally and, hence, utilized in an energetically efficient way. RWE has developed two vapour utilization concepts to industrial-scale:

- **Mechanical vapour recompression** as an open heat pump process for heating the drier’s heat exchangers with and without integrated lignite pre-heating
- **Vapour condensation** for preheating of, e.g., boiler feed water in the power plant process

**Drier design**
Coal feeding is fed via a star feeder into the slightly pressurised drier. A system specifically developed for the WTA technology which is installed in the drier’s upper section distributes the raw coal onto the fluidized-bed surface. The actual fluidized bed with the integrated heat exchangers is located in the central section of the drier. Heating is by low-pressure steam or alternatively (depending on the process variant) by recompressed vapour, the pressure ranging between around 3 and 4 bar. Fluidization is achieved by a system that is adjusted to the specific conditions of lignite drying. Below the fluidizing bottom, the dried coal is discharged from the fixed bed via star feeders. Fig. 3 shows the schematic design of the drier. It is characterized by a high specific capacity and a particularly compact structure.

Fig. 3: Schematic diagram of the drier

Fig. 4: Process principle of WTA fine-grain drying with vapour recompression

Fig. 5: Process principle of WTA with vapour condensation
The WTA drying process is characterized by a high specific capacity per square meter of the drier cross-sectional area and a low heating steam pressure. It is therefore possible to achieve a very high drying output per drier unit. The compact drier structure and the integrated fine milling system for the raw and the dry coal add up to a compact structure of the overall plant. Fig. 7 shows the prototype WTA, the world’s biggest drying plant for lignite, which is currently being built; it has a raw coal input of 210 t/h and an evaporation capacity of 100 t/h. As an alternative, all components of the raw coal flow can be arranged above each other in a steel structure.

- Safe plant operation as drying takes place in an inert atmosphere both during normal operation and during start-up and shutdown (avoidance of explosive coal dust mixtures)
- High drying capacity per drier unit
- Compact design thanks to the integration of raw coal fine milling and - where required – secondary dried lignite milling
- Thanks to the energetic vapour utilization large amounts of steam and dust emissions are avoided and the discharged vapour condensate is a water source that can be used in industrial processes
- Flexible adjustment of the plant equipment to the requirements of the individual drying task
The WTA technology is a proprietary RWE development that is specifically adjusted to industrial-scale application in the lignite industry. To meet the particular requirements of lignite processing and drying, innovative process- and plant-specific solutions have been developed for which 18 patents have been filed or granted yet. The evaluation of plant operation with domestic and foreign coals allows RWE to continuously develop and optimize the process.

Based on the comprehensive know-how gained in developing, planning, building, commissioning, and operating its own plants, RWE is able to offer a wide range of services:

- Feasibility studies incl. investment cost determination
- Bench-scale tests (processing, drying, fluidizing behaviour)
- Laboratory analyses
- Licensing of the WTA technology
- Industrial-scale processing and drying tests in the WTA 2 plant Frechen as a basis for designing licensed plants
- Basic and detail engineering
- Support during commissioning

Know-how and range of services

WTA plants completed and being planned

- **WTA 1 Frechen**
  Coarse-grain drying with integrated vapour compression and coal preheating
  Raw coal input: approx. 53 t/h; dry coal production: approx. 28 t/h

- **WTA 1 Niederaussem**
  Coarse-grain drying with integrated vapour compression
  Raw coal input: approx. 170 t/h; dry coal production: approx. 90 t/h

- **WTA 2 Frechen**
  Fine-grain drying with partial vapour condensation
  Raw coal input: approx. 27 t/h; dry coal production: approx. 14 t/h

- **WTA 2 Niederaussem (under construction)**
  Fine-grain drying with vapour condensation
  Raw coal input: approx. 210 t/h; dry coal production: approx. 110 t/h

- **WTA Hazelwood (being planned)**
  Fine-grain drying without vapour utilization
  Raw coal input: approx. 140 t/h; dry coal production: approx. 70 t/h

The WTA 2 Frechen and WTA 2 Niederaussem plants were planned, built, and commissioned by RWE acting as its own general contractor. For the other plants, RWE did the basic engineering and parts of the detail engineering. Fig. 8 shows the WTA 2 plant Frechen which is used for large-scale drying and processing tests with foreign lignites. The test lignites are discharged in the semi-open unloading point and filled into the raw lignite bin by a wheel loader (centre of photo).