



## ROTARY KILN AND DETONATION CHAMBER THERMAL DESTRUCTION OF SOLID ROCKET PROPELLANT AND LANDMINES IN PAVLOGRAD, UKRAINE

### SAFE, EFFECTIVE AND ECO-FRIENDLY DISPOSAL.

Within the scope of Ukrainian disarmament efforts there is a need to dispose of dangerous materials: solid propellant from intercontinental missiles and landmines. Ukraine is building a large-scale disposal complex near to the city of Pavlograd for the effective, safe and eco-friendly treatment of rocket propellants. Eisenmann provided the rotary kiln, detonation chamber and corresponding flue gas purification plant.

#### Disposal of SS-24 intercontinental missiles

The SS-24 intercontinental missile is equipped with multiple warheads (although other warheads are possible). It was manufactured between 1982 and 1991, primarily on the territory of Ukraine, and deployed by the Soviet Union during the Cold War period. The multi-stage SS-24 is propelled by solid fuel. The primary components are aluminum (Al) and ammonium perchlorate ( $\text{NH}_4\text{ClO}_4$ ). This is a highly reactive mixture, and disposal is technically challenging: if incorrectly handled, there is a risk of deflagration, in other words rapid combustion in conjunction with an explosion. Even if the combustion process is managed professionally, toxic gases are generated, containing contaminants such as hydrogen chloride (HCl) and nitrous oxides ( $\text{NO}_x$ ), which need to be reliably removed by means of a flue gas purification system.

#### The solution: a dual-chamber rotary kiln with refractory lining

The rotary kiln in Pavlograd is six meters in length, with a refractory lining. The lining ensures that the system can be safely and reliably operated at a temperature of 1,200 °C in the long term. The kiln is employed to destroy both the solid rocket propellant

itself and the fiberglass-reinforced epoxy cartridges that contain the fuel packs for each of the individual stages of the missile. The kiln can process approximately 850 kg of solid rocket propellant per hour.

#### Multi-stage flue gas purification

The toxic gases produced during propellant combustion pass into a second combustion chamber, operating at temperature of 1,100 °C. This is followed by the removal of nitrous oxides by means of selective non-catalytic reduction (SNCR). There is also a quencher for rapid cooling of the flue gases and a highly effective scrubber, including waste water treatment. The custom-tailored flue gas purification system can treat up to 3,300  $\text{Nm}^3$  of flue gas per hour. The result is a gas that complies with European thresholds and the requirements of Ukrainian authorities.

#### Detonation chamber for antipersonnel mines

Eisenmann installed a vertical detonation chamber, three meters in height, for the destruction of antipersonnel mines – palm-sized explosive devices. The chamber applies a defined quantity of heat to the landmines, bringing about a controlled explosion. The facility is designed to contain the resulting shockwaves and prevent the uncontrolled fragmentation of the landmines. The toxic gases released are treated by the same flue gas purification system as is used for the solid rocket propellant. The detonation chamber has a throughput of up to 400 mines per hour.

Construction of both plants commenced in February 2012, with operation beginning in January 2013.



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| Technical data        |  |
|-----------------------|--|
| Input materials       | 1. SS-24 intercontinental missile propellant<br>2. Empty motor cases of missiles<br>3. PFM-1 antipersonnel mines |
| Shape                 | cylindrical  |
| Length                | 6,000 mm   |
| Diameter              | 2,170 mm   |
| Lining                | yes  |
| Throughput            | approx. 850 kg/h   |
| Operating temperature | approx. 1,200 °C   |



Rotary Kiln

### Advantages at a glance

- Safe, reliable disposal of solid rocket propellant
- Compliance with all applicable thresholds for gas pollutants
- Rapid construction: completion within one year

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