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REFRATECHNIK

Processing instructions V 3.6.1
REFRAJET® Addmix nozzle

Note: Please read the product information sheet first, to ensure that these are the right processing instructions for your product. These instructions describe the use as well as the operating principle of the **REFRAJET® Addmix** nozzle.

It is essential that our **REFRAJET® Addmix** nozzle is used for installing **REFRAJET® Nanobond** refractory gunning concretes.
Optionally, this nozzle can also be used to install the dry gunning concrete types **REFRAJET®** regular, MC, LC, Hydrobond, Claybond, MW, LW, and NC, as well as **REFRASPECIAL®** and **REFRASPECIAL®** CBP. The gunning concretes mentioned above are dry mixes that are conveyed dry through a hose to the mixing nozzle of a gunning unit. In the mixing nozzle, the dry material is mixed exclusively with water before it is ejected from the nozzle at high pressure.

The instructions contained in this document must be complied with during processing and installation of the respective refractory concrete. Use and handling of the **REFRAJET® Addmix** nozzle in combination with the material type **REFRAJET® Nanobond** is described in detail in a separate processing instruction sheet (V 3.6). If, due to specific site conditions, it appears necessary to deviate from the procedures described here, please consult Refratechnik Steel GmbH before starting work. Modification of or deviations from the processing instructions can lead to major problems during installation, and possibly to total failure of the installed refractory material.

Design and operating principle of the injection nozzle – Basic function
In order to obtain certain processing and physical properties of the gunned concrete, a liquid or solid material is introduced into the material flow (dry gunning concrete mix) via the injection unit downstream of the gunning unit.

The nozzle consists of a dual-chamber system:
- Mixing chamber (merging of air flow and injected medium to generate an aerosol)
- Injection chamber (central injection of the aerosol into the dry gunning concrete mix)

Other nozzle components:
- Nozzles for various media to generate an aerosol in the mixing chamber region
- Injector pipe in the injection chamber
- Connections for conveying air, secondary air, material flow, and injection medium incl. shut-off devices
- Possibly a monitoring unit for throughput with liquids

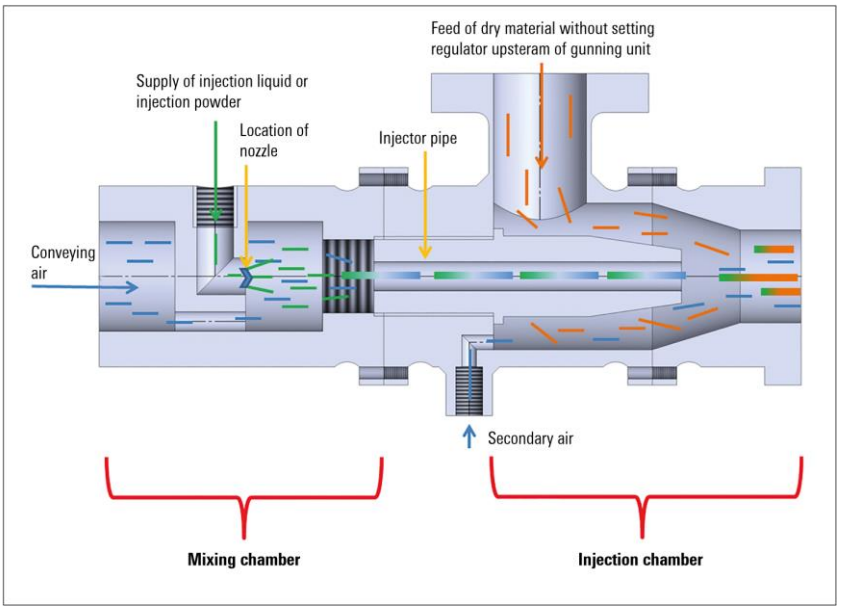

Fig. 1: Construction and operating principle of the **REFRAJET® Addmix** nozzle

Operating principle of mixing chamber
The mixing chamber is used to mix the conveying air with the respective injection medium in the correct ratio for the gunning concrete, and to generate a defined aerosol.

Aerosol generation from liquid media as injection medium:
The liquid is introduced into the air flow by means of a spray nozzle. Coming from the rear, the air flow passes in front of the nozzle. The liquid mist (aerosol) generated by the nozzle is thoroughly mixed with the conveying air and then guided into the injector pipe. The spray nozzle is selected according to density, pH value, viscosity, temperature, quantity, and pressure.

Aerosol generation from solid media as injection medium:
Solid media is introduced into the air flow in the same way as liquid media. However, a different nozzle must be used. Special nozzles for solid media are required. The nozzle is selected according to the physical properties of the solid medium.

Operating principle of injection chamber
The generated aerosol from the mixing chamber flows into the injection chamber through the injector pipe. Because the flow speed in the injector pipe is higher than that of the material flow from the gunning unit, the material is sucked up and intensively mixed with the injection medium. To prevent the formation of concrete deposits in the injection chamber, it is possible to inject secondary air. This simultaneously ensures an even higher turbulence of the gunning concrete in the injection chamber. The mix of injection medium and gunning concrete is passed to the hose system, at the end of which the mix is wetted in a mixing nozzle with liquid binder (with **REFRAJET®** Nanobond) or with water (with all other **REFRAJET®** dry gunning concretes).

Compressed air supply for REFRAJET® Addmix nozzle in relation to the compressed air supply for gunning unit:
The **REFRAJET® Addmix** nozzle must always be operated at the same compressed air pressure as the gunning unit. If the pressure is too high, the air will flow back into the gunning unit. Conversely, this presses the material into the injector tube, thereby clogging the nozzle. To prevent this from occurring, the air pressures of both systems are adjusted in parallel (synchronized) upstream of the gunning unit. In this way, identical compressed air pressures are ensured in nozzle and gunning unit. The pressure regulator on the gunning unit is kept fully open – the air pressure is always regulated parallel to the nozzle setting. Only the distribution of top and bottom air in the gunning unit can be individually adjusted. Best results are obtained with an air supply of up to 100% via the rotor (with rotor injection machines) and a slightly higher volume flow at the **REFRAJET® Addmix** nozzle. The pressure of the medium to be injected must always be about 3 bar higher than the conveying air pressure. This can be achieved e.g. with suitable diaphragm pumps.

REFRAJET® Addmix nozzle: Adjusting the volume flow (dry gunning mix / aerosol)

- Injection of the aerosol via the **REFRAJET® Addmix** system is

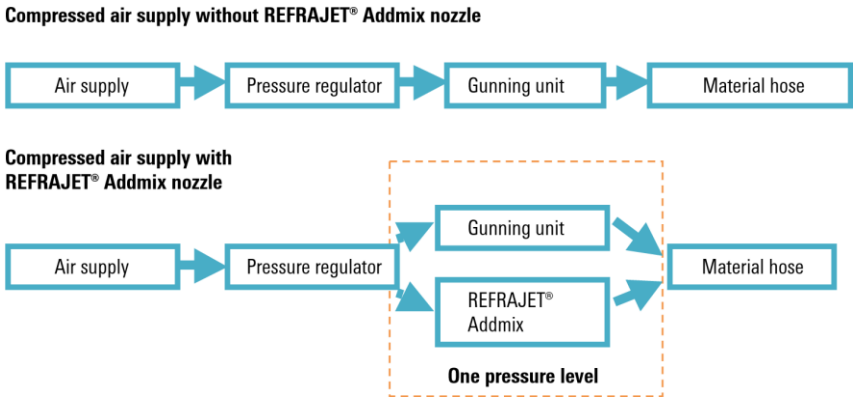

Fig. 2: Compressed air supply when using the **REFRAJET® Addmix** nozzle in comparison with the standard procedure

continuous, i.e. without interruptions. Hereby, the generated aerosol is injected immediately into the center of the dry material stream downstream of the gunning unit, without delays or interim storage. The continuous generation of aerosol as well as the immediately subsequent transport and injection at high flow speeds are the basic requirements for operating the nozzle and system.

- Particularly with **REFRAJET® Nanobond** concretes, the aerosol (**REFRAJET® Nanobond** accelerator) must be generated continuously, and be injected centrally into the dry material without delay. Hereby, and depending on local installation conditions, the injected amount can be varied. However, a minimum quantity of injected aerosol is essential. Without an injected aerosol, the dry **REFRAJET® Nanobond** gunning concrete mixes cannot be used.

- When using the **REFRAJET® Addmix** nozzle for cement-free dry gunning concretes of the **REFRAJET® Nanobond** type, a continuous generation and flow of material with a constant volume must be ensured. Particularly with dry gunning concretes of the **REFRAJET®** Nanobond type, this aspect becomes important, because installation problems can occur e.g. in case of underdosing or a discontinuous supply of aerosol. The use of **REFRAJET® Nanobond** materials always involves the compulsory use of our **REFRAJET® Addmix** nozzle. The combined use of **REFRAJET® Nanobond** dry material with the **REFRAJET® Addmix** nozzle results in a self-regulating system, which automatically leads to unsatisfactory installation results if the specified continuous volume flows (in particular the aerosol) are not observed.

Advantages of the new injection nozzle

- Dust generation is greatly reduced by injecting the liquid immediately downstream of the gunning unit or between gunning unit and gunning nozzle, thereby pre-wetting the material. Apart from the possibility of e.g. injecting a setting agent via this method, the nozzle permits other important processing and physical properties to be adapted and optimized (dust reduction at the gunning nozzle, lower rebound values, optimized strength, etc.).

- The introduction of liquids or powders during application (setting additive, accelerator, retarder, wetting agent, dust binding agent, etc.). Due to the pre-wetting effect, even the injection of small amounts of water results in the described positive effects (dust reduction, lower rebound losses, etc.).

- With cement-free **REFRAJET®** Nanobond refractory concretes, the addition of setting regulators during installation leads to significant advantages, because the storability (shelf life) of the dry mix, which does not contain setting regulators, is greatly increased. Binder and reactive partner are stored separately, thereby preventing a premature reaction. Also in this point, we see a clear advantage over the conventional procedure, in which all setting-relevant components are already included in the dry mix during production. In turn, this results in a significant limitation of storage time, whereas our dry gunning concrete mixes of the **REFRAJET®** Nanobond type are manufactured exclusively with refractory aggregates and without additives, thereby exhibiting a practically unlimited storage time.

- Another advantage of the dry component of **REFRAJET®** Nanobond lies in the fact that it does not contain any chemical additives, does not represent a health hazard, and can therefore be delivered to customers without special marking. Previously, an adequate amount of strongly basic chemical

additives (e.g. sodium aluminate, calcium hydroxide, etc.) to achieve a suitably strong reaction between liquid binder and dry component in the nozzle ring. If used incorrectly, this reaction can lead to health and environmental hazards.

- Thanks to the possibility of injecting a liquid additive before wetting the dry concrete mix with a mixing agent, this opens up new possibilities for optimizing various properties of the end product. For example, tests have shown that significant improvements (30...100%) are possible by injecting a liquid setting agent, as opposed to powder additives that are introduced into the dry mix. Also in this respect, the **REFRAJET® Addmix** nozzle exhibits clear advantages. As the present state of the art only enables powdery components to be included in the dry concrete mix, the reactivity of the dry mix component is considerably lower than compared with the liquid binder introduced at the gunning nozzle, and the use of highly reactive liquid agents.

- The gunning operator is not hampered by additional equipment or handling procedures. In this respect, our system differs from the various pre-wetting systems of other manufacturers. Operation of the **REFRAJET® Addmix** nozzle systems can be carried out by the machine operator, so that the gunning operator is not hampered in any way.

- Contrary to other conventional pre-wetting systems, our nozzle system injects the generated aerosol centrally into the dry material flow, downstream of the gunning unit. This offers the advantage of intense mixing as well as uninterrupted installation work, because the liquid aerosol does not come into contact with the inner hose wall, which could result in adhesions that can disturb or even block the material flow.

It is essential that our **REFRAJET® Addmix** nozzle is used for installing **REFRAJET® Nanobond** refractory gunning concretes. Optionally, this nozzle can also be used to install the dry gunning concrete types **REFRAJET®** regular, MC, LC, Hydrobond, Claybond, MW, LW, and NC, as well as **REFRASPECIAL®** and **REFRASPECIAL®** CBP. The following diagrams illustrate the operation of both procedures:

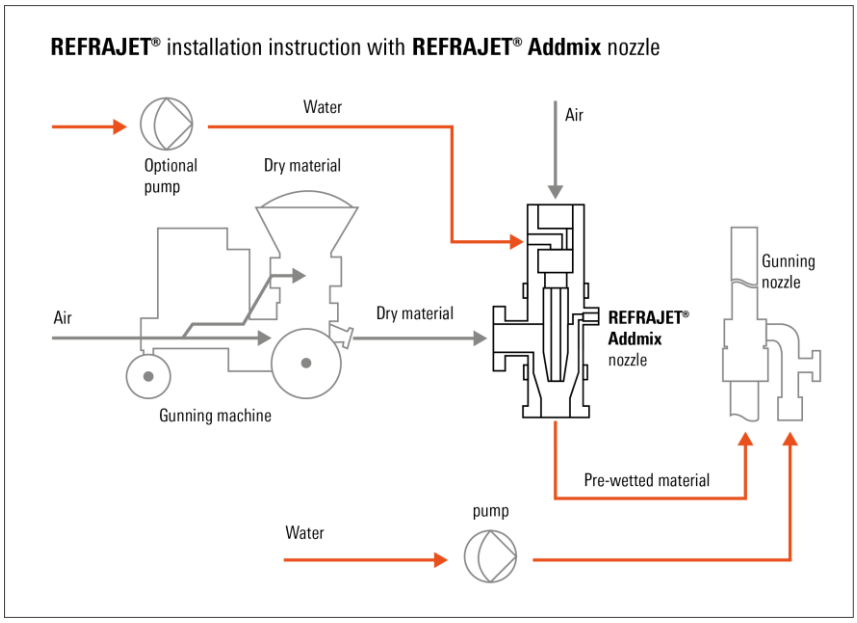

Fig. 3:
Use of the **REFRAJET® Addmix** nozzle for dry gunning concretes of the types **REFRAJET®** regular, MC, LC, Hydrobond, Claybond, MW, LW, and NC as well as **REFRASPECIAL®** and **REFRASPECIAL® CBP**

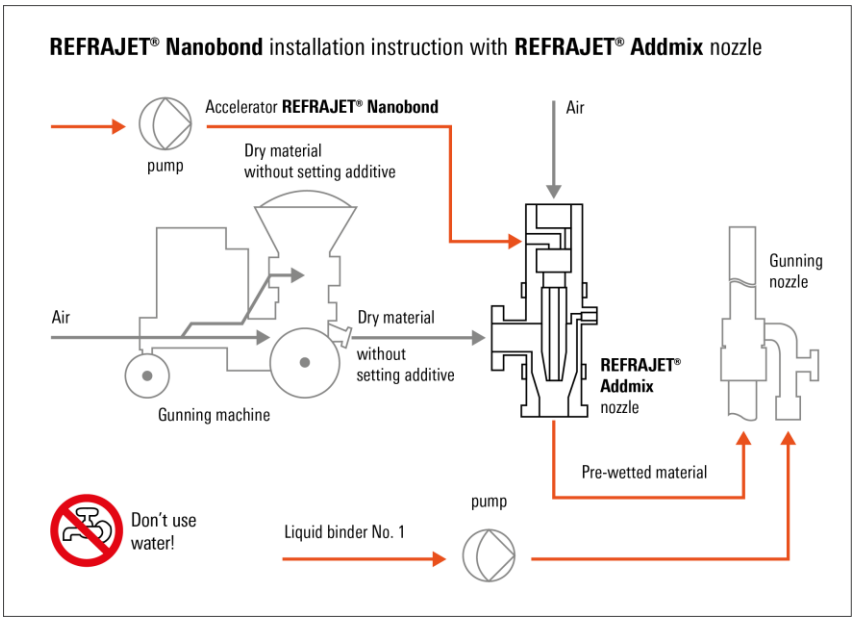

Fig 4:
Use of the **REFRAJET® Addmix** nozzle for dry gunning concretes of the **REFRAJET®** Nanobond type. Operating and handling of the **REFRAJET® Addmix** nozzle in combination with **REFRAJET®** Nanobond type material is described in detail in a separate processing instruction sheet (V 3.6.).

Operation of the REFRAJET® Addmix nozzle in combination with a dry mix gunning unit:

Switching on:

- Check whether the **REFRAJET® Addmix** nozzle and all other machine components have been connected correctly.
- Open the compressed air supply so that the gunning unit and the **REFRAJET® Addmix** nozzle are pressurized.
- Regardless of pressure, the air volume at the **REFRAJET® Addmix** nozzle must be greater than at the gunning unit.
- Start the dosing operation for the medium to be injected via the **REFRAJET® Addmix** nozzle.
- As soon as you note an aerosol at the gunning nozzle, you can start the gunning unit and thereby the flow of dry material.
- Now make the fine adjustments to the material flows to obtain an optimum gunning result.
- Ensure that the pressure of the injected medium is about 3 bar higher in the **REFRAJET® Addmix** nozzle than the conveying air pressure of the dry medium.
- Ensure a continuous material transport and supply of the injected medium to the **REFRAJET® Addmix** nozzle.

Switching off:

- Switch off the gunning unit and thereby the transport of dry material.
- Stop the dosing operation for the medium to be injected via the **REFRAJET® Addmix** nozzle.
- When no more aerosol appears at the gunning nozzle, permit the conveying air to flow for a short while before switching it off.
- If **REFRAJET®** Nanobond accelerator is used, thoroughly flush the **REFRAJET® Addmix** nozzle with water after longer interruptions in operation. For this, also switch on the conveying air in order to remove all traces of aerosol from the **REFRAJET® Addmix** nozzle and conveying hose.

Personnel health and safety

- Always wear suitable safety goggles, dust mask, protective clothing, and working gloves.
- Always wash thoroughly after working with the material.
- Observe the safety data sheets of the dry mixture, the **REFRAJET® Nanobond** accelerator, and the liquid binding agent.