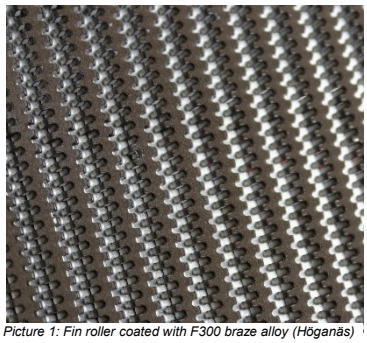
# Economic processing of high volume binder burn out in vacuum furnace

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**High temperature vacuum brazing of heat exchangers** is an established joining technology. New designs in heat exchangers and demand in substitution of Cu-foil to stainless steel brazing filler metal increase the brazing paste load per vacuum brazing batch. Significant increase in burn out gas volume require new furnace technology for economic and save processing the paste binder burn out process.

Since decades Schmetz high temperature vacuum furnaces working successful in the market of water-water heat exchangers, automotive heat exchangers and other industries like tools and medical. With this new developed burn out system for new and installed Schmetz vacuum furnaces effective burn out of paste binders is given by simultaneous protection of brazed products and parts of the furnace.



*Picture 1: Fin roller coated with F300 braze alloy (Höganäs)*

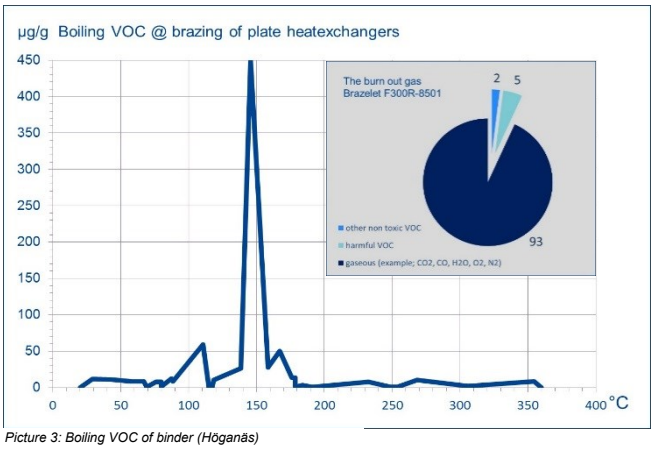
**Mass production of plated heat exchangers** require effective application methods together with tight control of alloy volume. Preferred application method today is to apply paste by roller coating. Compared to spraying or foil application roller coating significantly reduce the total amount of applied brazing filler metal (Picture 1). By use of Höganäs Brazelet F300R-8501 roller coating runs up to 20 m/min in single or multitrack coating lines. After dry off containing solvent the coated paste remains in place having a strong adhesion bonding withstanding further handling during storage and assembly.

**Brazing paste consist of an organic binder** and the brazing alloy as powder. The metal content and binder composition is function of the application method. Compared to dispensing paste roller coating paste needs different binder receipt for work proper. This binder require about 10 times higher polymer to work. A vacuum furnace pump station needs to be capable pumping 10 times more binder to gas volume. Binder burn out happen between 300 to 450°C (picture 2).

| Paste application | Dispensing | Roller Coating |
|---|---|---|
| Höganäs Brazelet | F300DW-9201 | F300R-8501 |
| Brazing alloy | 92% | 85% |
| Binder solvent | 7,7% | 12% |
| Binder polymer | 0,30% | 3% |
| Paste mass | 1000g | 1000g |
| Burn out gas | 3g | 30g |
| VOC condensation | 0,21g | 2,1g |

*Picture 2: Binder content in brazing pastes (Höganäs)*

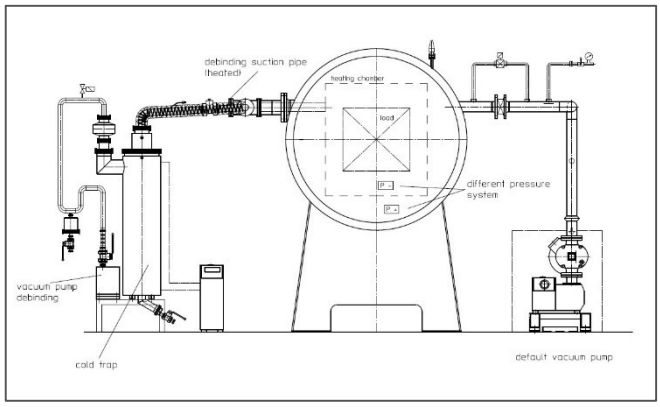
**Typical vacuum brazing paste profile** ramp up to 500°C awaiting total burn out of polymers. The polymers crack complete gas. 93% of polymers crack down to CO2, CO, H2O, O2, N2. About 5% binder crack down to harmful volatile organic compounds (VOC), like benzene, toluene, ethylbenzene and xylenes, about 2% polymer crack to nontoxic (VOC). In total 7% VOC condensate somewhere inside a standard vacuum furnace once reaching condensation temperature. The condensation temperature of all VOC vary from room temperature up to 360°C. Relevant volume condensation happen below 170°C. (picture 3).




*Picture 3: Boiling VOC of binder (Höganäs)*

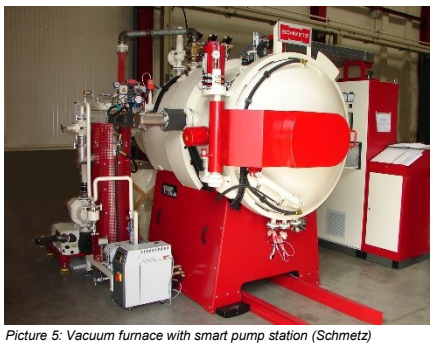
**Pumping power installation of vacuum furnace** must be in function of the burn out gas volume. The burn out gas should not get in contact to cold vessel wall resulting in uncontrolled condensation of binder. VOC condensate on vessel wall can evaporate during later stage in brazing process disturbing vacuum level and wear fine vacuum pump. In worst case scenario vacuum get lost total and furnace switch off heaters for safety protection.

**The new plug and play gas burn out pump station** is designed as a complete independent unit and can seamless installed to already operating Schmetz vacuum furnaces or opt in for new furnace investments. A vacuum pump sucks the released binder immediately out of the hot-zone and guides it to a cold trap system. The pump volume is scale based on estimated polymer load. This ensure protection of the vacuum vessel and main pump station. The fine vacuum pump never get any contamination by VOC. The cold trap system ensure controlled condensation of all VOC (picture 4).




*Picture 4: Schematic of gas burn out station (Schmetz)*

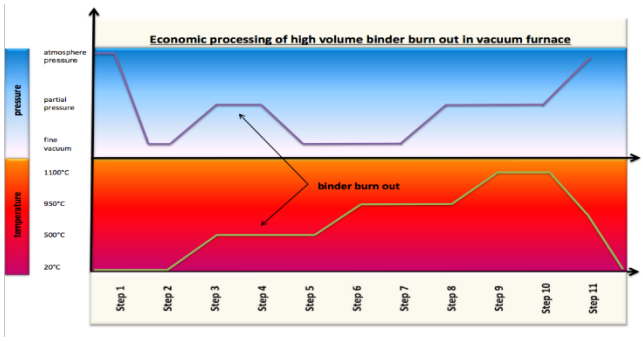
**The smart pump station maintain high productivity** independent of high polymer load. Already existing heat-treatment programs can be continue to use. The recommended brazing profiles of stainless- or nickel braze alloys do not need any change. A stable and reliable brazing process maintained together with low down times of vacuum furnace due to minimization of cleaning work. The unit use mainly standard components and available worldwide.



*Picture 5: Vacuum furnace with smart pump station (Schmetz)*

**Schematic brazing profile with smart pump station** for F300 stainless brazing paste is shown in picture 6. Time of segments is mainly function of furnace size and thermal mass of load:

**Step 1:** At room temperature pumping down to fine vacuum. This remove any moisture and oxygen out of the furnace and from batch load. **Step 2:** Partial pressure load with nitrogen, switch over vacuum pumps to smart pump station, heating up to 500°C. This homogenize and speed up heating of batch load to first temperature ramp. **Step 3:** Hold of 500°C until batch load reach temperature level and all binder burned out. **Step 4:** Switch back from smart pump station to vacuum furnace pump station, pumping to fine vacuum. **Step 5:** Heating up to 950°C. **Step 6:** Holding temperature to homogenize batch load. **Step 7:** (Optional) Partial pressure load with nitrogen or argon to avoid metal evaporation. **Step 8:** Heating up to recommended brazing temperature for F300. It is at minimum 1100°C. Higher temperature (e.g. 1150°C) can improve strength of braze joint. **Step 9:** Waiting for batch load to reach braze temperature. Extending the brazing time support strength improvements of braze joint. **Step 10:** Switch off heaters, awaiting natural cool down of batch load down to 900°C. **Step 11:** High speed cool down of batch load.




*Picture 6: Schematic braze profile with smart pump station (Schmetz)*