Final Report, February 07, 2019

# Pinch-Analysis
# Noyfil SA, Stabio (TI)

## Heat Recovery
## in Synthetic Fiber Production

Mit Unterstützung von

energieschweiz
Unser Engagement: unsere Zukunft.

**Diese Studie wurde mit Unterstützung von EnergieSchweiz erstellt.**
**Für den Inhalt sind alleine die Autoren verantwortlich.**
EnergieSchweiz**,** Bundesamt für Energie BFE
Mühlestrasse 4, CH-3063 Ittigen. Postadresse: 3003 Bern
Infoline 0848 444 444. www.energieschweiz.ch/beratung
energieschweiz@bfe.admin.ch, www.energieschweiz.ch

# 1 Summary

In Stabio (TI) Noyfil produces synthetic fibers mainly from PET. For this, the PET granulate is molten in about 35 different extruders and passed through very thin nozzles to produce a high number of filaments which afterwards are interlaced to a single string and coiled up.

Due to the small diameter of the filaments the water content in the raw PET needs to be very low. Therefore, the granulate is dried and crystalized by hot and dry air before entering the extruders.

To produce the necessary drying air, two centralized plants dehumidify ambient air first by cooling and second with silica gel to a dew point temperature of -60°C. Afterwards the dehumidified air is heated up to 145°C and distributed to the different dryers. The saturated silica gel is regenerated by ambient air which is heated to 140°C.

Process heat is generated by four gas fired boilers and distributed by a thermal oil circuit. With 4'850 MWh per year the dehumidification plants account for 92% of the natural gas consumption.

The following heat sources were considered in the Pinch-Analysis:

- Process return air of 125°C
- Air compressors 7.5 bar
- Air compressors 4.5 bar
- Thermal oil boilers
- Pyrolysis furnaces

With implementation of all the recommended measures the annual consumption of natural gas can be reduced by 2'060 MWh and that of electricity by 650 MWh. This corresponds to a reduction of the energy costs by 197'000 CHF per year. The overall payback time is 2.1 years.

After the Pinch-Analysis Noyfil already replaced two heat exchangers to improve the heat recovery from the process return air and additionally implemented some smaller measures to further reduce the consumption of natural gas. By this, the consumption of natural gas will be reduced by 1'300 MWh per year.

# 2 Performed activities

- Analysis of process requirements for drying of PET granulate
- Analysis of dehumidification process and possible alternatives
- Analysis of all relevant heat sources (air compressors, thermal oil boilers, pyrolysis furnaces)
- Measurements (especially air flow and electrical power of dehumidification plants)
- Definition of measures for operational improvements of the dehumidification plants
- Modeling of all relevant heat sources and sinks in PinCH software
- Design of economically optimal heat exchanger network
- Design of technically feasible heat exchanger network
- Definition of measures to reduce the consumption of natural gas
- Technical specification of the main components (heat exchangers)
- Calculation of the energy savings for each measure
- Clarification of technical feasibility & implementation with suppliers
- Inquiry of offers for the main components

# 3 Results and recommendations

**Improvement of heat recovery from process return air**

Both air dehumidification plants are already equipped with a heat recovery system to preheat the dry supply air by the return air (125°C) from the PET dryers. By replacing the existing heat exchangers with more efficient ones, the supply air can be preheated to 106…109°C instead of 63…83°C. This will reduce the consumption of natural gas by 1'090 MWh per year.

Finding a suitable heat exchanger for this application is especially challenging. The return air is slightly loaded with volatile compounds from the PET which deposits on the cold surface of the heat exchangers. During the analysis different heat exchanger designs and cleaning methods were evaluated. Finally, a solution with inexpensive and replaceable heat exchanger elements was realized.

With a final cost of 133'000 CHF to replace the two heat exchangers, the payback period is 1.9 years.

**Improvement of dryer operation**

By manually closing the dampers of all the PET dryers which are temporarily not in use, the flow of dehumidified process air can be reduced by an average of 20%. To avoid undesired pressure changes inside the supply and return ducts the supply and return fans need to be equipped with inverters.

The implementation of this measure will reduce the consumption of natural gas by 460 MWh per year and that of electricity by 290 MWh. Considering an investment of 83'000 CHF the payback period for this optimization is 1.4 years.

**Heat recovery from air compressors**

To regenerate the silica gel, ambient air is heated to 140°C and blown through the silica gel tanks.

By preheating the regeneration air to 70°C, using the cooling water of the air compressors, the consumption of natural gas can be reduced by 455 MWh per year. But to increase the cooling water outlet temperature of the air compressors to 85°C the installation of heat recovery kits is required.

Due to significant costs for the heat recovery kits of the air compressors and the long piping, the total investment is 250'000 CHF, resulting in a payback period of 8.6 years.

**Heat recovery from exhaust gas BONO boilers**

The exhaust gases of two thermal oil boilers can be used to preheat the regeneration air for the silica gel to 42°C, saving 240 MWh of natural gas per year. Since the boilers are located close to the dehumidification plant, this can be done by a gas/gas heat exchanger.

With an estimated investment of 70'000 CHF the payback period is 4.6 years.

**Replacement of process air fans**

For the distribution of the dry process air there are six process air fans with a total power of 480 kW installed. The analysis has shown that the efficiency of the process air fans is well below 60%, which is low compared to today's standards.

The fans should be replaced by new models, which achieve an efficiency of up to 80% if correctly sized. This will save 290 MWh of electricity. With an estimated investment of 90'000 CHF, the payback period is 3.1 years.