Mechanical vapor recompression for drying process at Hadano water treatment center

Figure 1: Heat pump-based sewage sludge drying system

Summary of demonstration case

At small and medium-sized sewage treatment plants, sludge generated in the sewage treatment process is mechanically dehydrated. The dehydrated sludge is carried out and disposed of. This industrial waste disposal cost is a heavy burden.

On the other hand, sewage sludge is expected to be used as a stable and large amount of biomass resource. For its utilization, sludge drying process is necessary. However, it is difficult to introduce conventional drying equipment, which requires a high cost, at small and medium-sized sewage treatment plants.

Hadano water treatment center has the similar challenges. In cooperation with Okawara Mfg. Co., Ltd. and Kansai Electric Power Co., Inc., they addressed the demonstration project using heat pump for the purpose of reducing drying cost as one of B-DASH (Breakthrough by Dynamic Approach in Sewage High Technology) projects. The demonstration project has been conducted as a government-commissioned research from NILIM (National Institute for Land and Infrastructure Management).

At this water treatment center, sludge of 9,360 t/a is generated. The average water content of the sludge is 72%W.B. (wet base). By the newly developed drying system, the sludge is dried to less than 20%W.B.

The newly developed drying system is composed of an indirect dryer and a mechanical vapor recompression system (Figure 2). In the dryer, sludge is heated by conductive heat transfer with the tubes in which steam flows. The dryer acts as a condenser. The drain from the dryer is decompressed with an expansion valve. The low-pressure wet steam is heated in an evaporator which recovers heat from exhaust gas. The dry steam is compressed with a roots blower and a screw compressor (by KOBELCO). The first-stage blower compresses the

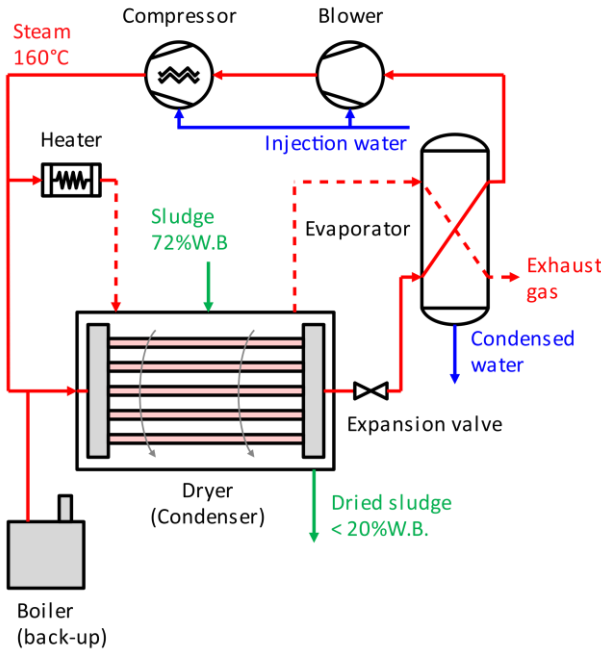

Figure 2: System configuration

steam to atmospheric pressure level, and then the second screw compressor compresses the steam to 0.5MPaG (160°C).

A part of the 160°C steam is superheated by an electric heater and is used for the carrier gas. A back-up boiler is also equipped and used in the case of the system start-up or the steam shortage.

Operating experiences

The drying system can reduce the life cycle cost by 22% compared to the case of outsourcing the waste disposal. On the other hand, compared to the case of drying the sludge with a conventional hot air rotary dryer, the newly developed drying system can reduce the life cycle cost, energy consumption and CO_2 emissions by 40%, 46% and 51%, respectively.

Special learnings

For the end-user, the decisive factors in the installation of the heat pump-based drying system were the followings:

- Reduction of total running costs (Reduction of industrial waste disposal cost exceeds additional electricity cost.)
- Easy operation and maintenance because of electricity system

FACTS ABOUT THE CASE

Intallation year: 2016

Working fluid used: R718 (water)

Compressor technology: Roots blower (Anlet) + Twin-screw compressor (KOBELCO)

System manufacturer: Hadano city office, Okawara Mfg. Co., Ltd. and Kansai Eectric Power Co., Inc.

Performance in design point:

- **Heat source:** 93°C (0.078 MPa, steam)
- **Heat sink:** 160°C (0.6 MPa, steam)
- **Heat supply capacity:** 675 kW
- **$COP_{Heating}$:** 2.9

Link to webpage:
https://www.jeh-center.org/asset/00032/monodukurinidenki/vol6_hadanocity.pdf

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All information were provided by the supplier without third-party validation. The infomation was provided as an indicative basis and may be different in final installations depending on application specific parameters.