

## High-efficiency Heat Pump “Neppu-ton” 90°C Hot Wind from the Heat of Air



Mitsubishi Heavy Industries Thermal Systems, Ltd., The Kansai Electric Power Company, Inc., Tokyo Electric Power Company Holdings, Inc. and Chubu Electric Power Co., Inc. jointly developed “Neppu-ton,” an apparatus for promoting energy saving through the replacement of the fossil fuel-based drying devices commonly used in industrial fields with heat pump systems.

### 1. Features of the product

- (1) Japan's first heat pump hot wind generator which uses air as a source of heat and generates hot wind of 90°C

In “Neppu-ton,” R134a is adopted as a refrigerant that circulates inside, thereby allowing the air-source heat pump to blow out hot wind of 90°C for the first time in Japan. As a result, “Neppu-ton” is a product suitable for high-demand drying processes using hot wind of 100°C or lower. Furthermore, by adopting a hybrid method in which the supply air of an existing drying device is preheated by “Neppu-ton,” this product can be used in drying processes requiring high-temperature hot wind exceeding 90°C.

- (2) High-efficiency operation by adoption of two-stage compression cycle

In “Neppu-ton,” a two-stage compression cycle was adopted in which two compressors are arranged in series. Thus, the workload of one compressor was reduced, such that the loss at the compressor was lowered, realizing high-efficiency operation.

- (3) High flexibility in installation due to the separate-type configuration, which is the same as air conditioners

Many high-temperature heat pumps that were applied to drying processes are hot wind heat pumps using water-source systems that recover heat from factory's hot wastewater. Such heat pumps require the installation of water pipes to circulate hot and chilled water and heat exchangers that produce hot wind, which posed challenges in terms of cost and difficulty in securing installation space.

As with air conditioners, “Neppu-ton” has a separate-type configuration comprised of an indoor unit and an outdoor unit. The outdoor unit (heat source unit) takes in heat from the atmosphere and the indoor unit (hot wind generator) can directly generate hot wind. The units are separately installed and are connected by the refrigerant piping. The outdoor unit, as an air heat source unit, can be installed anywhere and can even be installed inside a factory. The indoor unit, if it is a duct type, can be easily connected to an existing duct of a drying device, allowing the same duct installation work as general air conditioners.

The refrigerant piping work for the connection of the indoor unit and the outdoor unit is also the same as general air conditioners, and the same materials, such as copper pipe and heat insulating material, as those used in the piping for air conditioners can be used. The length of the one-way piping can be up to 50m, and the allowable difference of elevation between the indoor unit and the outdoor unit is up to 30m (in cases where the outdoor unit is installed on top of the indoor unit, and up to 15m in cases where it is installed under the indoor unit).

- (4) Measure at defrosting

“Neppu-ton” uses an air-source heat pump. As a result, when the outside temperature is

low, the moisture in the air freezes and frost is formed on the air heat exchanger of the outdoor unit. When frost is formed on the heat exchanger, the supply of hot wind cannot be continued, and defrosting is necessary. During defrosting, hot wind cannot be supplied. Taking countermeasures against this is the biggest issue for air-source heat pumps.

To address this issue, it is recommended to adopt a hybrid method where an existing drying device such as a steam boiler or a hot wind generator is used as-is and “Neppu-ton” is used as backup heating for the air supply by the existing drying device. In a hybrid method, the control method where the hot wind supply temperature is gradually decreased before defrosting is performed was adopted for “Neppu-ton” so that temperature adjustment using the existing drying device is also possible.

(5) Use with remote monitoring system

By using the remote monitoring system common to the CO<sub>2</sub> refrigerant heat pump water heater for commercial use, “Q-ton” and the air-cooled heat pump chiller “MSV,” which are manufactured by Mitsubishi Heavy Industries Thermal Systems, Ltd., the following proposals can be made to customers:

- In an emergency, email is sent for early repair.
- 24-hour monitoring of operational data allows for prevention or maintenance before a failure occurs.

## 2. Specifications of the product

Table 1 shows the specifications of “Neppu-ton.”

**Table 1 Major specifications of “Neppu-ton”**

Item		Performance
Performance	Heating capacity <sup>(*)1</sup>	30kW
	COP <sup>(*)1</sup>	3.5
	Indoor unit suction air flow rate <sup>(*)2</sup>	24.8m <sup>3</sup> /min
Heat source		Air heat source
Exhaust temperature setting range		60 to 90°C
Indoor unit air flow rate setting range		18 to 50m <sup>3</sup> /min
Operating range		Outdoor air temperature: -5 to 43°C Intake temperature: -5 to 43°C
Inside and outside piping length		Maximum one-way: 50m
Refrigerant		R134a
Legal refrigerant ton		2.84 ton <sup>(*)2</sup>
External dimensions [mm]		Outdoor unit: H2048×W1350×D720 Indoor unit: H380×W1150 (+86 <sup>(*)3</sup> ) ×D648 <Connection duct size: 300×900>
Weight		Outdoor unit: 379 kg Indoor unit: 66 kg

(\*)1 Value under the conditions of outdoor air temperature of 25°C (relative humidity of 70%), indoor unit intake temperature of 20°C and exhaust temperature of 80°C

(\*)2 Since the legal refrigerant ton is less than 5 tons, notification under the High-Pressure Gas Safety Act is not required.

(\*)3 Size of the control box on the side of the indoor unit

## 3. Application example and energy saving performance at the application site

“Neppu-ton” was applied to a dry laminator <sup>(\*)4</sup> for drying, and the energy saving performance was evaluated. The results are as follows:

- (\*)4 Device for laminating two or more films. After an adhesive is applied to one of the films, the adhesive is cured by hot wind, etc., for adhesion.

The heat source unit of the existing drying device was a steam boiler, in which the steam heater was used to generate hot wind of 70°C to 80°C to dry film. In this case, “Neppu-ton” was applied for air supply heating.

Figure 1 shows the state of the indoor units of “Neppu-ton” installed, and Figure 2 shows the diagram of the system with “Neppu-ton” applied to the dry laminator.

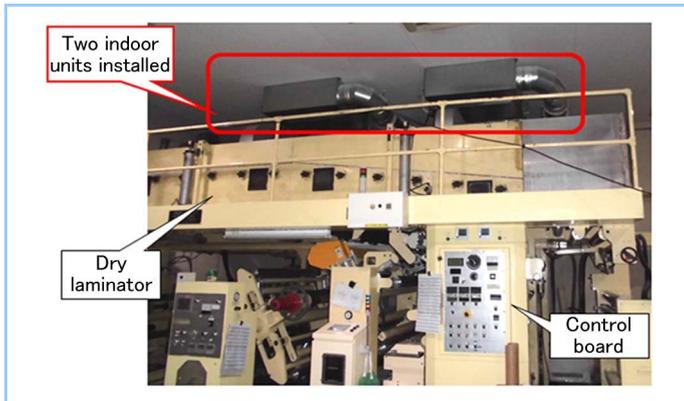


Figure 1 State of the indoor units of “Neppu-ton” installed

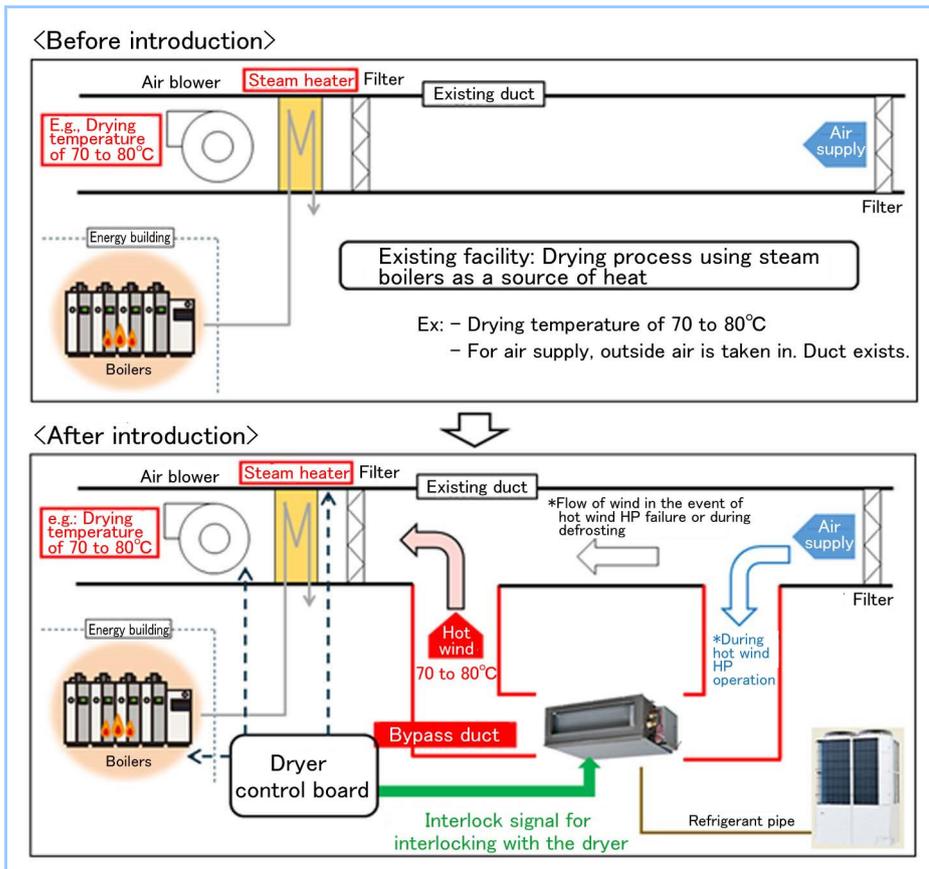


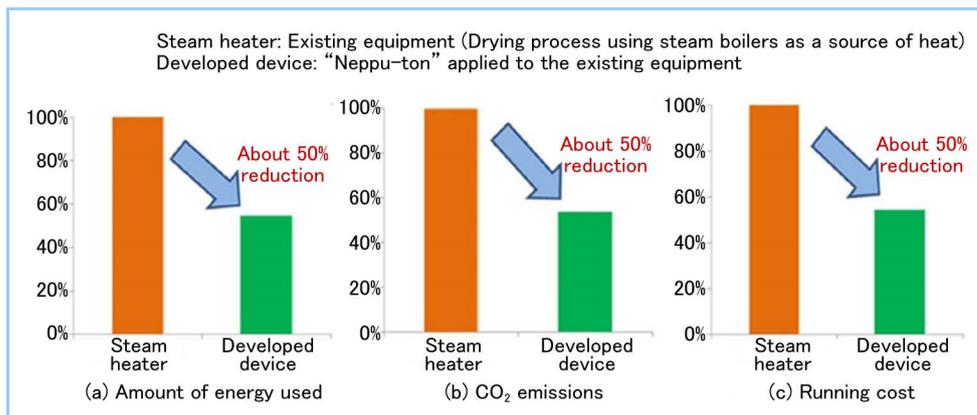
Figure 2 Diagram of the system with “Neppu-ton” applied to the dry laminator

In the application of “Neppu-ton,” a bypass duct was newly installed as shown in Figure 2, to which “Neppu-ton” was applied, while the existing boiler as a source of heat, steam heater and its duct were kept.

With this configuration, even if the air flow of the existing dryer is larger than that of “Neppu-ton,” the required air flow can be supplied from the existing duct. Thus, “Neppu-ton” can be applied to a dryer that has a larger capacity or air flow and the decrease in temperature during the defrosting of “Neppu-ton” can be prevented.

In this application case, for “Neppu-ton” to be interlocked with an existing dryer for operation, the system is configured to operate based on the interlock signal received from the existing dryer using the “Remote starting and stopping/monitoring kit” which is an option of the package air conditioners manufactured by Mitsubishi Heavy Industries Thermal Systems, Ltd. With this configuration, when only the drying device is operated as before, “Neppu-ton” can be automatically operated. Consequently, “Neppu-ton” can be applied without increasing the labor of field workers.

**Figure 3** shows the effect in the case of “Neppu-ton” being applied to the dry laminator. Using “Neppu-ton,” the amount of energy used, CO<sub>2</sub> emissions and the running cost were reduced by about 50%, and the high energy-saving performance of “Neppu-ton” was confirmed.



**Figure 3** Summary of the dry laminator measurement results

## 4. Future development

Mitsubishi heavy Industries Thermal Systems, Inc. developed “Neppu-ton,” which is a high-efficiency hot wind generator that uses an air-source heat pump. A major contribution by “Neppu-ton” to energy saving in industrial fields can be expected. We are going to spread the use of “Neppu-ton” in industry, thereby reducing energy consumption and CO<sub>2</sub> emissions and promoting global environmental conservation.

“Neppu-ton” also enables the blowout of high-temperature wind, which general air conditioners cannot realize, allowing the development of applications for factory air conditioning as a substitute for steam heating or electric heaters.