RESULT 375
JP 90.510/3X H04

CADDET energy efficiency
IEA
OECD

Compact heat exchanger integrated into air duct system

Summary

A Japanese electronics company has developed a new type of gas-to-gas heat exchanger, called the Ductron. The heat exchanger has a simple structure composed of aluminium or stainless steel pass partition plates stacked with a gas passage (1 cm wide) between each plate, and can be installed as part of an air duct system. It is applicable not only to HVAC systems but also to various industrial applications. The efficiency level is over 50%. The payback period is very short (in some cases less than one year) owing to low initial costs and almost zero extra maintenance and running costs.

Highlights

- **Heat exchange efficiency exceeds 50%**
- **Applicable for HVAC and industrial use**
- **Installation and maintenance cost savings**
- **Short payback period**

Heat exchange duct – Ductron.

Aim of the Project

Heat exchangers are usually used to transfer waste heat between the exhaust and the supply air streams, to provide heating and cooling. However conventional heat exchangers take up a lot of space and connecting them to supply and exhaust air ducts requires extensive work and high costs. These systems also lead to air pressure losses that add to the running costs. Filters preventing heat exchange elements from becoming clogged also require frequent inspection, maintenance and replacement, which increases maintenance costs considerably.

This project's aim was to develop a compact heat exchanger that did not entail extra expenses for installation, operation and maintenance, while being able to use supply and exhaust air at a constant flow rate.

As a result, a duct-type heat exchanger, the Ductron, has been developed for the commercial market, using the same space as the duct installation. It has effective heat exchange efficiency without impairing the original function of the duct system.

The Principle

The Ductron has a simple structure composed of stacked aluminium or stainless steel pass partition plates, with a 1-cm wide space between each plate. The unit can be installed as part of a duct system, thus eliminating the need for extra space (see Figure 1).

The dimensions meet the standards for ordinary ducts and there is a cross-sectional area for an air passage larger than that of the ducts to which it is connected, keeping pressure loss to around the same level as ordinary ducts. The air passes through the 1-cm wide opening in the heat exchange section, making it unnecessary to fit the filters usually required to protect a heat exchange unit. This means that the maintenance work usually required after installing a heat exchanger, such as cleaning the filters, is no longer required. If the heat exchange section becomes clogged, then its simple structure makes it easy to deal with the problem.

This ensures that the initial costs are minimised, and the running and maintenance costs are very low. Heat exchange efficiency of over 50% is realised through its innovative structure (patented No. 285758). As it needs very little electricity, this heat exchange duct can achieve an overall efficiency higher than standard gas-to-gas heat exchangers. The efficiency level does not drop when operating with a large air volume as there is low static pressure loss. It is also possible to run two units in sequence or in parallel. Two Ductrons in sequence, or the efficient longer type of Ductron, can achieve heat exchange efficiency of 75% or more.

The Ductron can deal with a wide variety of gases, including those containing large amounts of water vapour. Gas leakage between the sides of the heat exchanger rarely occurs. The stainless steel can withstand high temperatures of 150°C or more. The Ductron has high durability and can function well in industrial environments. It is very quiet and helps to dampen other sounds.

The Situation

Table 1 shows the results of a simulation involving the introduction of heat exchangers

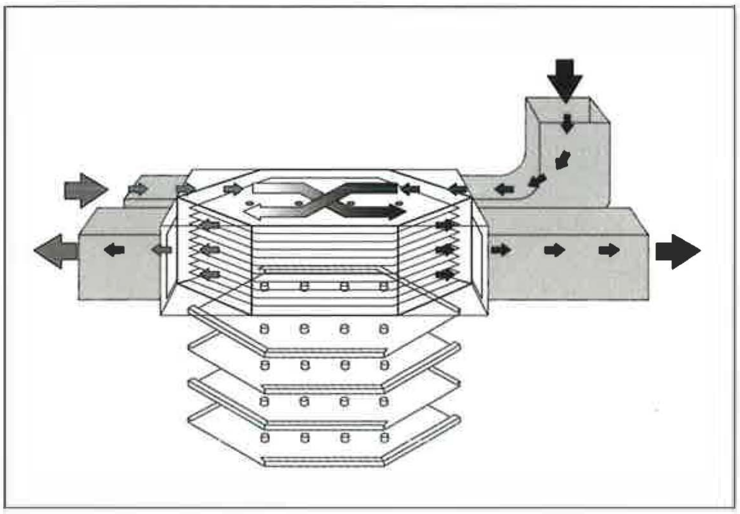

Figure 1: The structure of the Ductron heat exchanger.

into an HVAC system for an amusement arcade with a floor area of 600 m^2 and a ventilation air volume of 202,000 m^3/hour. It is assumed that the Ductron works at 40% heat recovery efficiency.

The results show a 38.6% saving in power consumption. This is slightly higher than the 37.4% saving from an ordinary air-to-air heat exchanger operating at 65% efficiency, but the latter would need additional power for a fan to compensate for the increased static pressure loss. In a real project, introducing a Ductron heat exchanger into an existing HVAC system in a bank saved 14% energy for cooling and 30% for heating.

One of the features of the heat exchange duct is that it has a wide application in industry. For example, a car assembly plant uses a Ductron unit to recover heat from the 150°C exhaust of a forging machine. This is used to provide localised heating in its large factory, without increasing the fuel bill.

The Ductron, combined with a water spray, is used to cool the factory in a food processing plant. Initial costs are less than half that of conventional methods, with almost no running costs. It also prevents condensation on water pipes during the summer.

The heat exchange unit can also be used for purposes other than space heating and cooling. A parts manufacturer operates a hot-air dryer by using supply air heated from 9°C to 45°C by the Ductron. Another company

Table 1: Comparison of power consumption costs (JPY) and investments.

		Without heat exchange	**Ordinary heat exchanger**	**Ductron**
HVAC operation	Time and days	9:30 - 22:30 (13 hours per day), 25 days per month		
	Season	Cooling: 4.5 months; Heating: 5 months; Intermediate: 2.5 months		
Temperature & humidity	Cooling season	Outdoor air: 35°C, 70 %; Indoor air: 25°C, 50 %		
	Heating season	Outdoor air: 0°C, 50 %; Indoor air: 22°C, 50 %		
HVAC equipment	Compressor	33 kWe x 4 = 132 kWe (422 kWth)[1]	33 kWe x 3 = 99 kWe (317 kWth)[1]	33 kWe x 3 = 99 kWhe (317 kWth)[1]
	Fan	11 kWe x 2 = 22 kWe	11 kWe x 3 = 33 kWe	11 kWe x 2 = 22 kWe
HVAC loads	Winter	230 kWth (72 kWe)[1]	230 kWth x (1 - 0.65) = 80.5 kWth (25.2 kWe)[1]	230 kWth x (1-0.4) = 138 kWth (43.2 kWe)[1]
	Summer	286 kWth (89.5 kWe)[1]	286 kWth x (1 - 0.65) = 101.1 kWth (31.3 kWe)[1]	286 kWth x (1 - 0.4) = 171.6 kWth (53.7 kWe)[1]
Daily power consumption	Winter	Total 1,058.2 kWhe	Total 429 kWhe	Total 324.6 kWhe
	Summer	Total 1,967.7 kWhe	Total 1,355.6 kWhe	Total 1,058.6 kWhe
	Intermediate Fan	286 kWhe	429 kWhe	286 kWhe
Annual power consumption		371,412 kWh (100)	232,688 kWh (62.6)	228,168 kWh (61.4)
Annual power expense		6,685,000	4,188,000	4,107,000
Saving in annual power cost			2,497,000	2,578,000
Increase in maintenance cost by heat exchanger			1,050.000[1]	30,000[2]
Net annual running cost saving			1,447,000	2,548,000
Initial cost saving by decrease in compressor units			5,000,000	5,000,000
Incremental initial cost by heat exchanger			10,000,000	7,000,000
Net incremental initial cost			5,000,000	2,000,000
Payback period			3.46 years	0.78 years

1) Monthly inspections and filter change, and annual cleaning.
2) Annual inspection, and cleaning every third year.

halved the fuel costs for its product dryer by utilising this heat exchange duct.

A waste incineration plant uses the Ductron to condense steam evaporated from cooling water, preventing the chimney from discharging white smoke and preheat combustion air. This reduces the cooling water and white smoke by 90% and reduces fuel costs by 40%.
A Ductron installed in a medicine-manufacturing mill as a flue-gas treatment facility for its waste incinerator is performing the same level of exhaust gas treatment as conventional treatment facilities. Equipment and installation costs are about half and the running costs around one-third those of conventional facilities.

The Company

Japan Electronic Technical Co. Ltd, with JPY 20 million in capital, was founded in October 1985. The company manufactures electronic equipment and machinery, designs and installs automatic control systems, and manufactures and markets heat exchange equipment.

Economics

The initial cost of installing the Ductron is less than that of an ordinary ventilation air heat exchanger of an equivalent capacity. Maintenance and running costs are also lower. The payback period is short, less than one year in some cases (see Table 1).

Manufacturer

Japan Electronic Technical Co. Ltd
3117-8, Arai-cho Nishiura,
Owari-asahi-shi,
Aichi Prefecture 488-0077,
Japan
Tel.: +81-561-545271
Fax: +81-561-545285
E-mail: jet@gctv.ne.jp

Information Organisation

New Energy and Industrial Technology Development Organization,
NEDO Information Center
Sunshine 60, 30F, 1-1,
3-chome, Higashi-Ikebukuro
Toshima-ku, Tokyo
170-6030,
Japan
Tel.: +81-3-9879412
Fax: +81-3-9878539
E-mail: caddet@nedo.go.jp

Please write to the address below if you require more information.

CADDET energy efficiency IEA * OECD

Swentiboldstraat 21,
6137 AE Sittard,
PO Box 17, 6130 AA Sittard,
The Netherlands,
Telephone: +31-46-4202224,
Telefax: +31-46-4510389,
E-mail: caddet@caddet-ee.org
Internet: http://www.caddet-ee.org

* IEA: International Energy Agency
OECD: Organisation for Economic Co-operation and Development

IEA

The IEA was established in 1974 within the framework of the OECD to implement an International Energy Programme.
A basic aim of the IEA is to foster co-operation among the 24 IEA Participating Countries to increase energy security through energy conservation, development of alternative energy sources, new energy technology, and research and development (R&D).

This is achieved, in part, through a programme of energy technology and R&D collaboration currently within the framework of 40 Implementing Agreements, containing a total of over 70 separate collaboration projects.

The Scheme

CADDET functions as the IEA Centre for Analysis and Dissemination of Demonstrated Energy Technologies. Currently, the Energy Efficiency programme is active in 12 member countries and the European Commission.

This project can now be repeated in CADDET Energy Efficiency member countries. Parties interested in adopting this process can contact their National Team or CADDET Energy Efficiency.

Demonstrations are a vital link between R&D or pilot studies and the end-use market. Projects are published as a CADDET Energy Efficiency 'Demo' or 'Result' respectively, for ongoing and finalised projects.