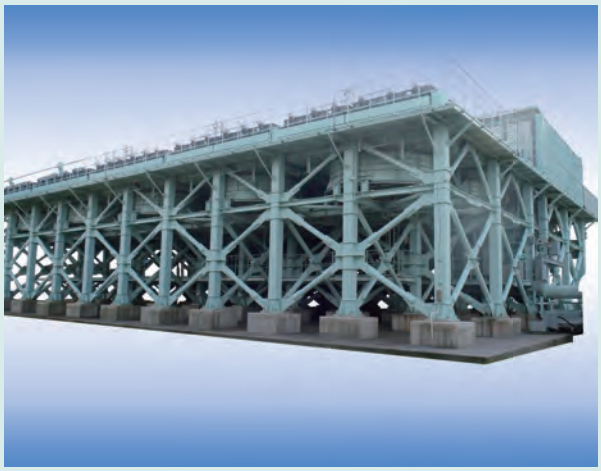
Air fin cooler (AFC) – Excellent earthquake resistance helps make nuclear power station safer



Increased earthquake resistance in nuclear power facilities has been in great demand ever since the Great East Japan Earthquake. In response, Kawasaki has added reinforcements and made structural improvements to its air fin coolers (AFC). Seismic analysis results have shown that these improvements have raised the eigenvalues of major components, attaining sufficient stiffness.

Accordingly, Kawasaki will now be able to provide AFCs with excellent earthquake resistance to help make nuclear power stations safer.

Preface

Following the 2011 Great East Japan Earthquake and subsequent tsunamis, there has been an increasing demand for diversification in nuclear power plant facility cooling methods, and in an increasing number of cases air is being used in place of seawater to cool equipment.

1 Objective

Nuclear power plants are equipped with diesel power generation equipment to be used for emergency power generation in the case of an accident or other such circumstance that prevents the regular provision of electricity, and seawater is often used as the coolant for these diesel generation facilities.

However, in order to diversify cooling methods in pursuit of greater levels of safety, an increasing number of plants have adopted air fin coolers (AFCs). There is a high demand for cooling facilities that remain undamaged even in the event of an earthquake, thus preserving cooling capabilities.

In consideration of such demand, we at Kawasaki have improved the earthquake resistance of our AFCs.

2 AFC structure and specifications

(1) Structure

Our AFC's external appearance and form are shown in Fig. 1. In general, AFCs comprise the following components:

① Tube bundles
② Fan
③ Motor and reduction gear
④ Fan ring
⑤ Framework
⑥ Louvers (upper and side louvers)

Cooling liquid is fed through the tube bundles (heat exchanger tubes) and cooled via air from the fan. Each component device is supported by a highly earthquake-resistant framework, enabling the AFC to continue functioning even in the event of an earthquake. In addition, if the upper louvers become blocked by snow during the winter, air can be exhausted from the side louvers, enabling the equipment to function regardless of snow accumulated on top.

Please note that the AFC depicted in Fig. 1 is of a two-bay design. Our AFCs are divided in units known as "bays," and the number of bays can be increased or decreased as necessary according to heat exchange quantity requirements. Each bay's basic structure adheres to a standardized form, which enables reduction of time normally required for design and analysis as well as cutting of installation costs.

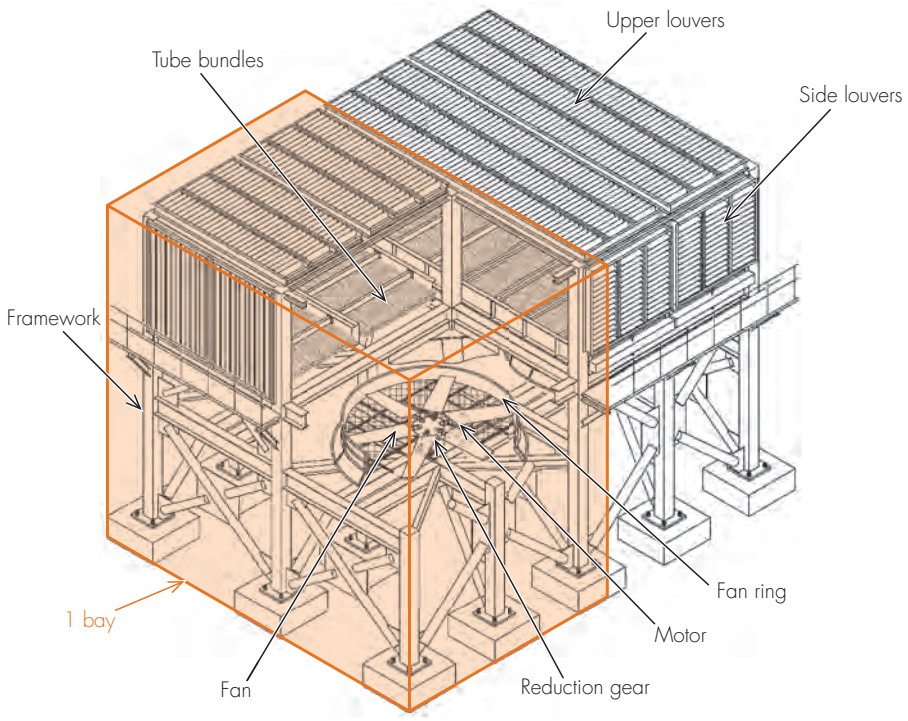


Fig. 1 Air fin cooler outline (2 bays)

Table 1 Air fin cooler specifications

Type	Forced draft
Earthquake resistance rating	S*
Equipment class	JSME** Codes for Nuclear Power Generation Facilities class 3 container
Heat exchange quantity	Approx. 1.3 MW per bay (varies according to temperature conditions)

* S represents the highest class of earthquake resistance.
** JSME: Japan Society of Mechanical Engineers

(2) Specifications

The specifications for Kawasaki's standard AFCs are outlined in Table 1.

3 Improved earthquake resistance

High earthquake resistance is required of AFCs. In the past, the soundness of support frameworks, the fan section and so forth in the event of an earthquake was confirmed via analysis based on specified seismic conditions. In response to increasingly strict requirements regarding seismic force conditions in recent times, we have made improvements to the fan and fan ring (see Fig. 2), tube bundles and other individual components. We have also added ribs, braces and other reinforcing parts to reduce deformation caused by earthquakes, and modified structural forms and increased the numbers of bolts used at joint sections which are subject to greater

concentrations of stress.

The presence or lack of sufficient structural rigidity is determined using eigenvalue analysis: requirements as of late call for values exceeding 33 Hz, and through the abovementioned improvements eigenvalues for the fan ring and tube bundle framework have, as shown in Fig. 3, fulfilled structural rigidity requirements.

4 Measures against snow accumulation

Our AFCs are equipped with louvers designed to provide a countermeasure to snow accumulation. In order to enable proper exhaust of hot air generated by the heat exchange process regardless of snow accumulation on top of the equipment during the winter, the upper louvers are closed

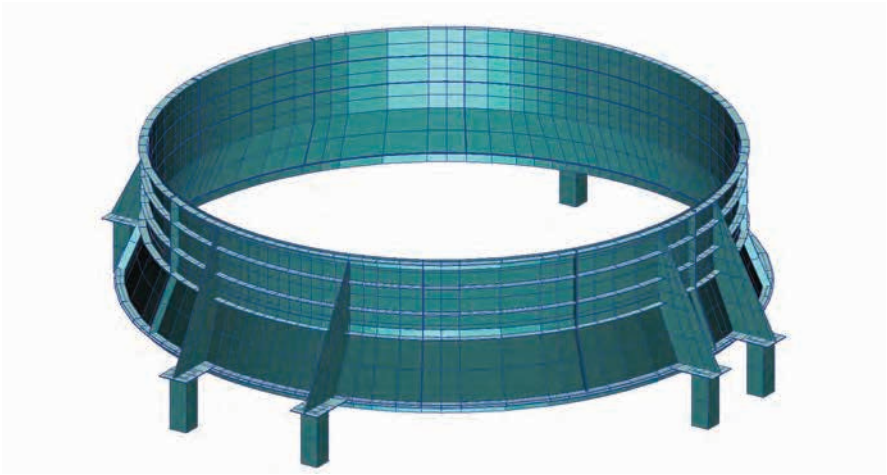


Fig. 2 Seismic analysis model of fan ring

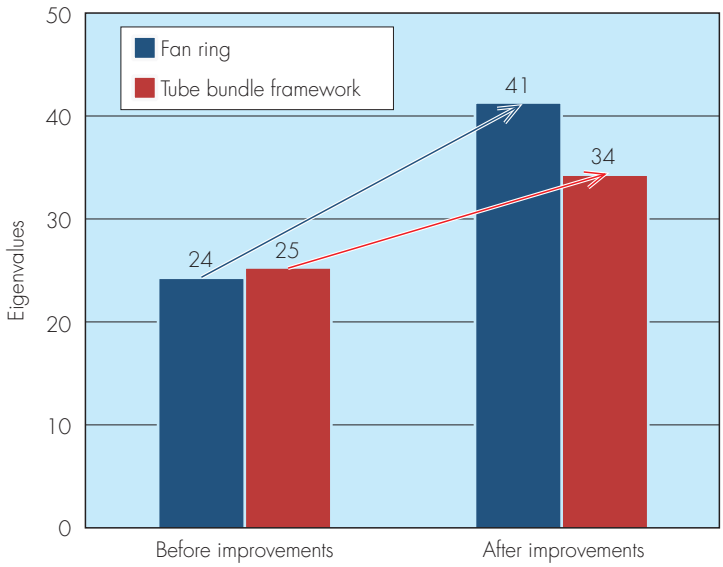


Fig. 3 Rise in eigenvalues after improvement

Table 2 Completed deliveries

Client	Year of installation	Heat exchange quantity	No. of units
Fukushima Daiichi Nuclear Power Station Unit 4, Tokyo Electric Power Company, Inc.	1996	5. 27 MW	1 unit (3 bays)
High Temperature Engineering Test Reactor, Japan Atomic Energy Agency	1996	3.5 MW	1 unit (4 bays)
Shimokita Reprocessing Plant, Japan Nuclear Fuel Ltd.	2002	11. 6 MW	2 units (9 bays each)
		4. 45 MW	2 units (4 bays each)

during the winter and air exhausted from side louvers instead, enabling continued AFC operation. Although it is possible to equip AFCs with snow-melting heaters to prevent snow accumulation on top, the water produced by melting snow may refreeze and hinder machinery operations. Furthermore, because necessary utility supplies such as steam and electricity (for heaters) may be cut off in the event of an earthquake, louvers are suitable as an earthquake safety measure.

5 Past installations of Kawasaki AFCs

We have successfully installed our AFCs in various nuclear-power and related facilities in the past (see Table 2), and we are currently preparing designs for installation of our system at the J-POWER (Electric Power Development Co., Ltd.) Ohma Nuclear Power Station.

Postscript

Following the Great East Japan Earthquake and subsequent tsunamis, demand for increased safety at nuclear power plants has been strong. At Kawasaki, we strive to contribute toward safer nuclear power plant operations through relevant safety measures.

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