

Copper Stream Volume 14

Zoom Up Copper:



The length of the copper tubes used in the indoor unit of the separate type air-con can be 2.2 times longer!

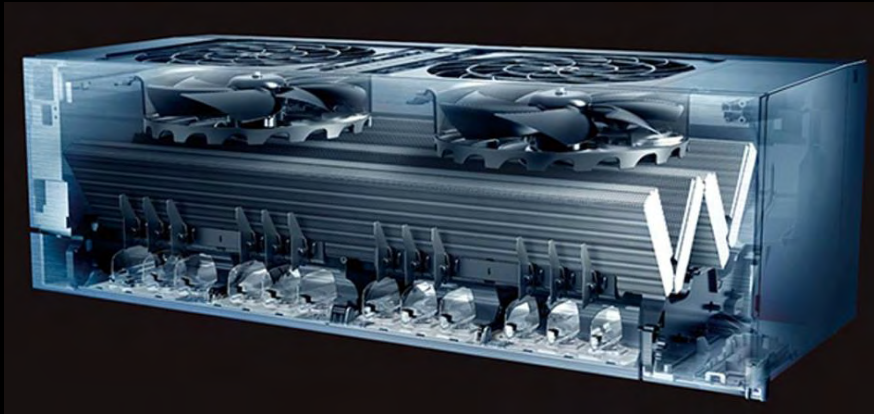
Room-type air-conditioners are now the integral part of Japanese housing, rather than one of the home appliances and considered essential for our living, therefore, every single room in our households is equipped with a room air-con. It had been said the market would be saturated, yet, the number of shipping-out units steadily grows over 8 million per year since 2010, and it reached over 9.4 million in 2013.

The challenge for the industry is now to deliver “Comfortableness and Energy Saving” at the same time. It is copper tubes for refrigerant used in the heat exchanger that address the issue. The more the copper tubes are in the units, the greater the saving will be. So the manufacturers had various efforts of their own to increase the volume of the copper tubes. But the Japanese housing environment does not allow a large indoor unit, then the space for copper tubes in it is quite limited. Some manufacturers tried to increase the size of outdoor unit so that the larger amount of copper tubes can be used, but again, the size of the balcony in the apartment complexes where the outdoor unit is normally installed is limited. So everybody more or less gave up on the idea of increasing the amount of copper tubes.

But in 2015, Shizuoka Works, Living Environment Group, Mitsubishi Electric Corp., developed an indoor unit with copper tubes about 2.2 times longer than the conventional ones. Here is the story about how they made the 'impossible' possible.

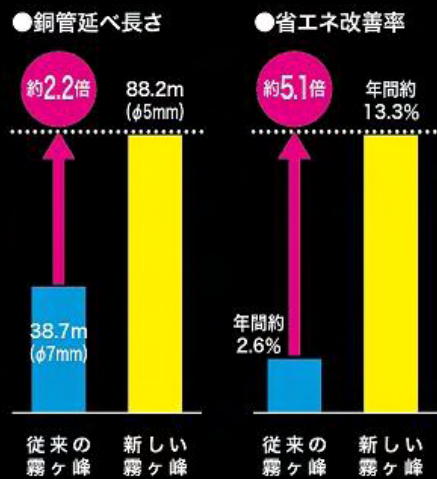


Shizuoka Works of Mitsubishi Electric Corp. was established in '54 to manufacture fridges and HVAC equipment as well as to serve as an R&D Center for those. About 1.2 million air-cons are annually shipped out of this plant, which is fully automated with the cutting-edge technologies.



The new structure that pushed the envelope of the concept of 'energy saving' - this has set the next generation standard for the split-type air-cons

Total length of the copper tube used 2.2 times greater.
Total energy saving 5.1 times improved.



(blue bar - existing) (yellow bar - new)

**Succeeded in making the total length of the copper tubes used greater!
Innovative to change the method that had been used for almost half a
century.**

Mitsubishi Electric Corp. developed the wall-type room air-conditioner nearly 50 years ago. They have branded the air-con as “Kirigamine”, and been so proud of the technologies used in their invention that had awed the industry; the technology is called “Line-flow fan”, or a cross-flow / tangential fan, the compactness of which made the product very successful in the Japanese housing environment.

Even 50 years after the launch, the line-flow fan still is the standard technology of the room air-con in Japan. Yet, Mitsubishi have now come up with the new model of “Kirigamine” that would not use the line-flow fan. The reason of moving away from the technology they have been so proud of, is that they concluded they would need to use more copper tubes as the refrigerant container in the heat exchanger if they pursue for further energy saving. In that way, the heat exchange between the air and refrigerant can effectively occur. Up until 2000, the effectiveness of heat exchange had continued to improve by making the copper tube diameter smaller, from 7 mm to 5 mm, improvement of the motor performance, or changing the shape of the fans, etc. But there had no room of improvement after that, therefore, they had to think of the innovative way to save the energy, such as structure design change.

That is how the new propeller structured “Personal Twin Flow” system was developed. Like in the case for the line-flow fan, this “Personal Twin Flow” has been used first in the world for the split-type room air-cons. In this new system, new model of Kirigamine uses total 88.2m length of copper tubes, from 38.7m of the previous model. Previous model has done only 2.6% of the annual energy saving, and the new model can achieve about 13.3% or more than 5 times greater than the previous model.

It is not just the replacement of the fans to propeller type, but involves reengineering of every single part of the device.

Bold design change in the indoor unit for new Kirigamine - what is the biggest difference / improvement?

The biggest difference is the position of the fan in the unit; previously the roll-shaped fans were situated in the middle of the unit. When the fans rotate, the air from the copper tubes of the heat exchanger which surrounds the fans can be sucked into the fan-side [fig.1]. Due to this design, the space allocated for copper tubes are quite limited.

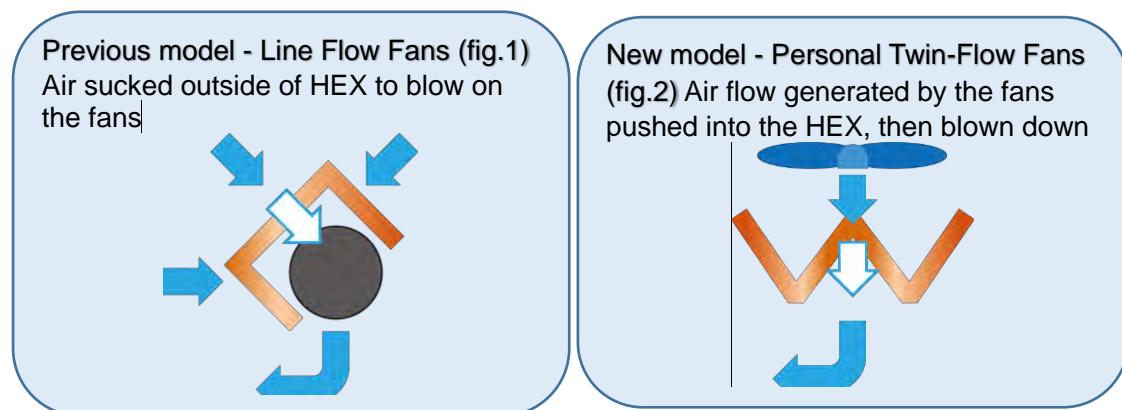
The new Kirigamine has the propeller structured fans are situated on the upper part of the unit, and the air blows down on the copper tubes of the Heat exchanger[fig.2]. So, there can be more room for the heat exchanger, in the other words, more space for the copper tubes.

Needless to say, this structure change cannot be achieved only by replacing the conventional fans to propeller ones. It requires the redesigning and reengineering the whole unit, such as to have the propeller fans compact enough to fit into the space above the tubes, as well as having the heat exchanger shaped in the way to exchange the heat efficiently.

The outdoor unit also had to be redesigned to balance out the performances of the heat exchangers for both units. After the numerous trials and errors, they came up with the optimum design of the indoor unit.

For this renewal, the motor has been reengineered to enhance the performance, which required the redesigning for every single part. Then, the total energy saving has become the level of 'miracle'.

The new heat exchanger has W-shaped to accommodate longer copper tubes.



(blown – Heat Exchanger)

Excellent thermal conductivity, workability and antimicrobial property...many reasons for copper to be the standard material for the refrigerant tubes in air-cons.

Approximately 10K tons of copper are used every year for tube in indoor and outdoor units of room-type air-cons in Shizuoka Works of Mitsubishi Electric. Additionally, the plant here produces industrial packaged type air-cons which are used in the commercial buildings such as the offices and stores, as well as refrigerators. Copper tubes are used for all of these products/

The main reason for keep using copper tubes is the high thermal conductivity. Also its malleability is great to work on the tubes for room air-cons, because it can be designed with sharp curbs to fit in the limited spaces. Engineers also point out its corrosion resistant and antimicrobial properties, too. The air blown into the room should not contain lots of germs and bacteria. Especially the Japanese condominiums today tend to have a joint kitchen-living room, so the tube should better be strong against both grease and dusts.

Apart from the use for the tubes, air-cons also use copper for its compressor and coils of fan-motors. Continuous effort to improve its efficiency is being made here, and various types of compressors need to be developed. The key for improvement largely depends of the thickness of the copper wire: Its diameter would range between 0.8 and 1.1mm ϕ , but in principal, the thicker the copper wire is, the greater the energy saving is. Currently average thickness of the wire diameter is 1.4 times larger than the one used in the past.

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Succeeded to deliver further comfort by this innovative design change.

Another reason to motivate the engineers at Mitsubishi Electric is the 'pursuit for the ultimate comfort' for the users.

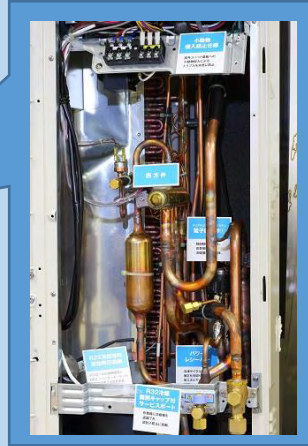
Kirigamine is equipped with a function called "Move-eye", which is the sensor to detect the body temperature of each individual person in the room while analyzing the room temperature - even under the same environment, some people would feel chilly and some too warm. Personal Twin-flow system has 2 propeller-type fans, so individual person in the room can get the most comfortable air flow for their own need. Also, when the room temperature reaches to the level desired, cooling operation automatically changes to ventilation only. They name it as "Hybrid Operation" and can drastically improve energy saving rate.

At Shizuoka Works cite, there is a show-room where people can experience the new Kirigamine's cutting-edge technology. There are also displays of various kinds of their products; room-type air-cons, packaged type air-cons for offices and stores, compressors, etc. Every display has detailed explanation and the visitors can see how copper is used in those products as tubes and wires.

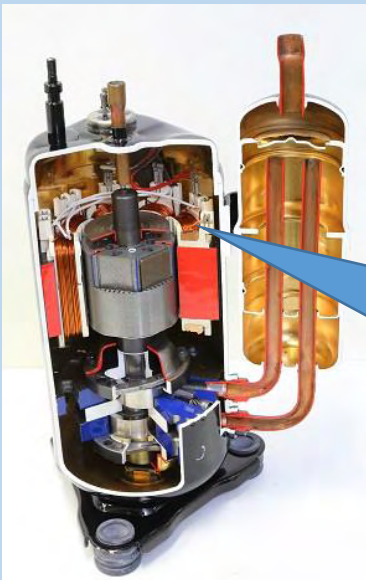
Some manufacturers are shifting from copper to other materials due to the material's price volatility, but Mitsubishi people believe in copper. "When I think of corrosion, copper is the most reliable material and have no plan to move away from copper for a while" says one of the engineers at Shizuoka Works.

Utilizing copper's properties to deliver the comfortableness and energy saving, Kirigamine has been awarded with "Energy Saving Prize" by the Minister of Economy, Trade and Industry in 2015, which is considered in Japan the highest prize for a commodity item. Also, Shizuoka Works of Mitsubishi was awarded Energy Saving Grand-Prix by President of Energy Conservation Center.

Display at Shizuoka Works, Mitsubishi Electric - "Hybrid Kirigamine" with 'move-eye'; how the sensor works and analyzes the individual body temperature and separate ventilation system can be experienced; visitors can also learn the history of the product / brand. Inside of the units are exhibited in the cut-out model so where the copper is used and how the material can improve the efficiency can be seen



The weight of copper tube is 25% of outdoor unit regarding industrial package type air-con.



Copper wire and tube are used as main parts in the compressor.

