# Utilisation of Waste Heat Generated in Electric Motors

Electric motors are among the most efficient machines in the world. However, they are also industry's biggest users of energy which is why electric motor efficiency is high on the agenda of government authorities and large corporations around the world.

The IEC 60034-30-1 standard published in March 2014 defines the current highest IE4 efficiency class for electric motors, with the ensuing IE5 class currently under development. These are incremental improvements and soon we will hit the limit when it will not matter how much more steel lamination and copper we add to motors – the improvement in efficiency is bound to become disproportionate to its cost.

It is therefore logical that, rather than pushing the electrical efficiency higher and higher, some of the large users of electric motors will look at utilisation of the waste heat originating from inside the electric motors.

There are a variety of losses naturally occurring within electric motors. Losses originating in electric motors have been categorised into Joule losses caused by the electric current passing through copper conductors in the stator winding. In squirrel cage motors Joule losses are also caused by the induced current passing through the rotor cage. Losses originating in a motor’s steel lamination are classed as magnetising losses.

Mechanical losses mainly include friction losses in bearings and shaft seals, whereas ventilation losses are caused by the motor's cooling fan as well as air resistance and turbulence caused by the rotor as it spins inside the stator. Lastly, there are other stray electro-magnetic losses, the test and calculation method of which has changed a few times in the last 35 years.

Eventually almost all losses transform into heat, which needs dissipating through the motor's ribbed frame into the surrounding environment. This heat is usually considered waste heat. Some large motor users however have now started to consider the possibility of utilising the waste heat originating in electric motors, in order to use it in their manufacturing processes or to simply generate hot water for their buildings.

However, this is difficult to achieve when standard air-cooled motors with ribbed frames are being used. People are therefore increasingly considering water jacket cooled motors as another option. Water is a much better thermal conductor than air. As a result, water jacket cooled motors are better cooled and substantially smaller than air-cooled motors of the same

output and speed. A direct comparison between a few examples of air-cooled and water jacket cooled motors can be seen in the table below.

| Motor specification | Cooling | |
|---|---|---|
| | Water | Air |
| 90 kW 2pole | 200L | 280M |
| 110 kW 2pole | 225M | 315S |
| 132 kW 2pole | 250M | 315M |
| 160 kW 2pole | 280M | 315L |

A small circulation pump is needed to keep the cooling water moving through the motor's cooling jacket and the heat exchanger where the otherwise wasted heat gets transferred over for further utilisation. The overall energy efficiency improvement when the heat is fully utilised more than offsets the small additional electricity usage.

The use of relatively small industrial squirrel cage motors in water jacket cooled execution for energy saving is not normally practical. However, if we consider big pumping or compressor stations where several very large electric motors run side by side, then this whole concept starts to make sense.

If we look at a 200kW 2pole IE4 MEZ motor its efficiency is 96.5% with waste heat of around 7kW. If only 5kW of this heat could be utilised for heating buildings, or pre-heating various process fluids, the potential savings are equal to more than two oil filled radiators, the heating power of which is usually around 2kW each. However, IE4 motors are the most efficient motors on the market at the moment and in reality IE3, IE2 or even IE1 motors are still operating at most of the sites which in comparison create far more waste heat that could potentially be reused.

Welkon Limited is the UK representative of Obeki Motors, a specialist manufacturer of bespoke and special motors whose portfolio includes water jacket cooled motors. Obeki manufactures both induction motors and generators as well as permanent magnet motors and generators in water jacket cooled execution, which are often tailored to specific customer needs.

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**About Welkon**

Jerry Hodek has now established a new company called Welkon Limited and is representing MEZ electric motors manufactured in the Czech Republic and stocked in Belgium and the specialist Obeki electric motors manufactured in Spain.

The emphasis is on premium products and on specials, which include water jacket cooled motors, permanent magnet motors and generators as well as drop-in replicas of old induction motors both Squirrel Cage and Slip-ring made by manufacturers who are no longer in existence.

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**Picture 1:** Because water is a much better thermal conductor than air, water jacket cooled motors are better cooled and substantially smaller than air-cooled motors of the same output and speed.

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