# The level of minimum energy efficiency requirements for centrifugal Forward Curved fans

*Forward Curved = FC*
*Backward Curved = BC*

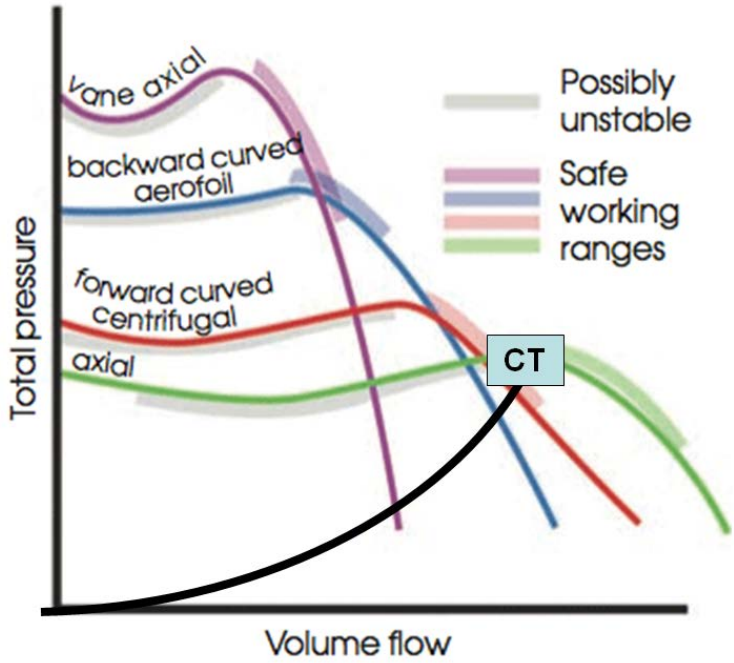
Because the exemption proposal for evaporative cooling towers from the fan regulation is still in consideration and the cooling tower industry utilizes the centrifugal FC fan technology in a lot of products, we want to share below arguments against the proposal.

The discussion document defined the proposed minimum efficiency per fan type in table 5 of page 43. Wherein the current regulation distinction is made between FC and BC centrifugal fans, this is simplified in the discussion document. Only one minimum efficiency requirement is set for all centrifugal fans. This minimum efficiency for centrifugal fans is based on the BC centrifugal fan data although FC centrifugal fan technology cannot meet this minimum efficiency requirement.

In the Cooling tower industry centrifugal FC fan technology is used because of the specific characteristics of these fans:

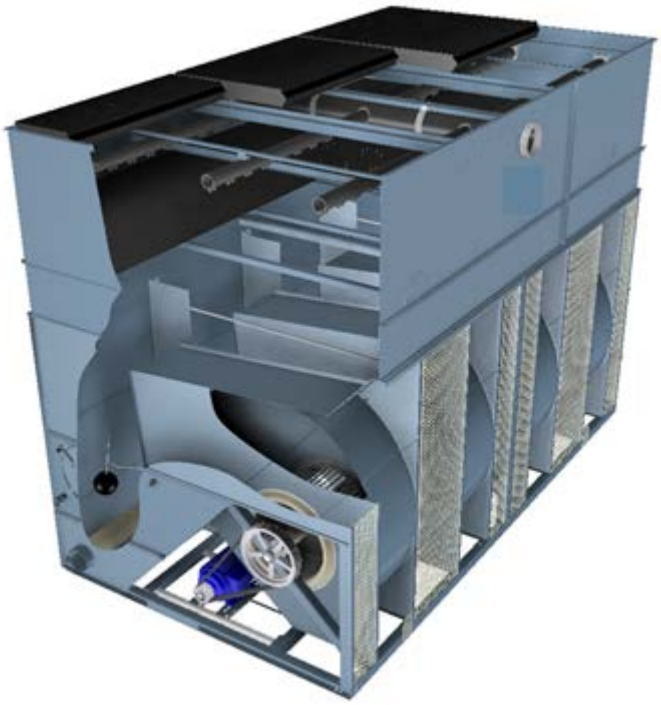
- Best energy efficiency fit for the required high volume and medium pressure working point
- Low rpm reducing sound power level for applications that would not be met with axial propeller fan technology.
- Best size fit for the required high volume and medium pressure working point.
- Able to overcome external pressures applied in ducted applications that would not be met with axial propeller fan technology.

FC centrifugal fans have a different performance curve than BC centrifugal fans. The FC centrifugal fans are more in line with the needs for the forced draft cooling towers: medium pressure and high volume flow. For a given size envelope, the Forced draft cooling tower duty point is usually right of the curve of the BC centrifugal fan. The BC fans usually can’t get the equivalent airflow of a FC centrifugal fan as shown on the figure below without an increase in size that would be impractical due to shipping size limitations and necessary air plenum space required to distribute air to the heat exchanger.




Via an example a comparison is made between FC and BC centrifugal fans.

Consider a forced draft cooling tower with 2 centrifugal fans, delivering a total volume flow of 27.8 m³/s at a static pressure of 199 Pa. Such a cooling tower is similar to the one shown on the picture below.



With FC centrifugal fans of 30”, the power consumption is only 17.4 kW. Delivering the same performance with a 30” BC centrifugal fan requires 21.9 kW electrical power. Installing BC

centrifugal fans is not only less efficient, but also a larger motor size is required; from 18.5 kW to 22 kW.

Total efficiency is 56.6% for the FC centrifugal fan and 45.1% for the BC centrifugal fan. The FC centrifugal fan is compliant with the minimum efficiency for 2015 (> 44.4%) but not with the proposed minimum efficiency in 2018, 70%. The BC centrifugal fan is already not compliant with the (current) minimum efficiency for 2015 (>61.8%). BC centrifugal fans don't offer a solution with respect to increased efficiency on the forced draft centrifugal cooling towers.

BC centrifugal fans require an increased rotation speed compared with FC centrifugal fans to achieve the same performance. Considering the example, the FC centrifugal fan rotates at 360 rpm but the BC centrifugal fan requires 1048 rpm. This influences the noise made by the fan. Because the blade tip speed is the main driver for noise, the sound power level would increase at least 14 dB(A). This is huge and is not accepted by the market due to local laws on sound. A lot of the forced draft centrifugal units are already installed with intensive attenuation to align with sound requirements. Further sound attenuation is not practical given the necessary air restriction would greatly degrade heat exchanger performance causing more energy consumption.

The increased rotation speed of BC centrifugal fans influences the cooling tower design intensively. Bearings, shafts, supporting structure, motors and drive need to be reviewed and redesigned. As an example the current shaft rotating the centrifugal fans has a critical design speed of 575 rpm, the BC centrifugal fan rotates at almost double this speed. Bearing size depends on the rotation speed of the shaft. Increasing the rotation speed will increase the bearing size. The increased weight of the BC centrifugal fan (355 kg) versus the weight of the FC centrifugal fan (126 kg) must also be taken into account of a redesign.

In this cooling tower the fan housing (scroll and snout) is fully integrated in the product as a supporting structure for the heat exchanging section above (see picture above). Secondary the BC centrifugal fan technology requires a different fan housing resulting in an entire redesign of the product. Based on the above arguments to redesign the product, the end product will consume more raw materials which also affect the environment negatively and also cost will increase.

This example shows that an introduction of BC centrifugal fans into the forced draft centrifugal cooling towers will not be beneficial for the fan efficiency. The FC centrifugal fans are necessary to achieve best fan efficiency. The proposed minimum efficiency for centrifugal fans is too extreme considering the FC centrifugal fan technology.

An introduction of BC centrifugal fans into the forced draft centrifugal cooling towers will also not be beneficial for noise. Increased sound power levels will not be accepted by local laws.

It will also not be beneficial to the environment with the regards to the increased consumption of raw materials.

It will also not be beneficial to the industry and market due to increased cost.