ENGINEERING LETTER | 30
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CENTRIFUGAL AMCA FAN ARRANGEMENT 8 VS 7 (AND 3)

Introduction

The question is often asked which fan arrangement is better between an AMCA arrangement 8 (Figure 1) or arrangement 7 (Figure 2) and arrangement 3 (Figure 3) when selecting a Single Width Single Inlet (SWSI) fan. The following items should be considered when making this decision.

1) Size constraints and the design of the rotor.
2) Ducting and installation considerations.
3) Initial Cost (CAPEX) and Operating Cost (OPEX)

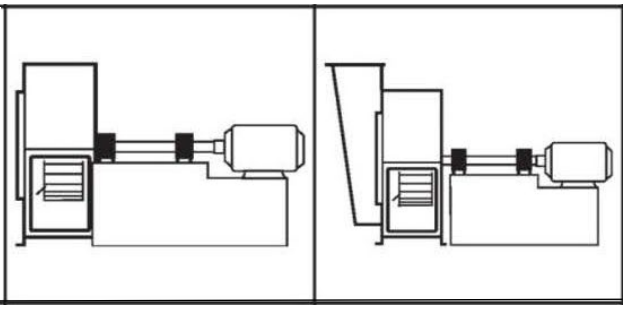
AMCA Arrangement 8	For direct drive. Generally, the same as Arr. 1, with base for the prime mover. Alternative: Bearings mounted on independent pedestals with or without inlet box.	

Figure 1(1)

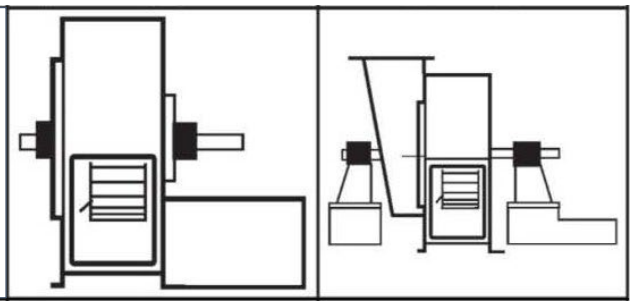
AMCA Arrangement 7	For coupling drive. Generally the same as Arr. 3, with base for the prime mover. Alternative: Bearings mounted on independent pedestals with or without inlet box.	

Figure 2(1)

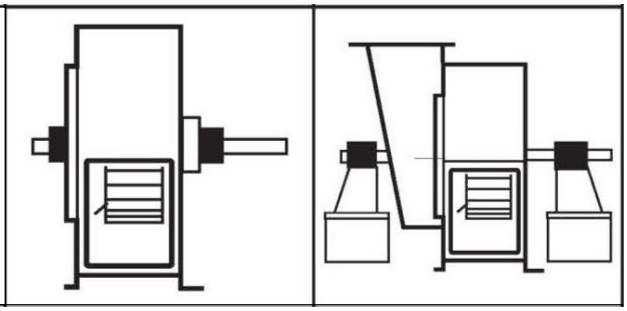
AMCA Arrangement 3	For belt or direct drive. Impeller mounted on shaft between bearings supported by the fan casing. Alternative: Bearings mounted on independent pedestals with or without inlet box.	

Figure 3(1)

Size constraints and design of the rotor

The primary consideration is to determine what shaft and bearing combination can be designed to support the radial (weight) and axial (thrust) load generated by the impeller. The rotor is comprised of the impeller, shaft, bearings and coupling. Arrangement 8 can only be used for fans that can be sized utilizing a SWSI fan. Any fan that needs to be a double width double inlet (DWDI) in order to meet the performance requirements will be an arrangement 7 or 3 DWDI. One of the design processes for a fan rotor is an iteration stepping through the different shaft and bearing options and fan operating speeds to determine the shaft size, bearing type and size, bearing lubrication, and bearing cooling requirements to meet industry design standards and customer specifications. If the impeller is too large, generates too much thrust (large pressure rises across the fan) or the customer's specification requires only a certain bearing, lubrication and cooling method, then arrangement 7 or 3 may be the only option.

Ducting and installation considerations

Customer installation requirements such as requiring a straight duct into the inlet of the fan (no inlet box), placing fans in series, or a fan with the smallest footprint would suggest an arrangement 8 fan would be preferred. These requirements may be specified for process aerodynamic reasons, space limitations or to keep the initial cost (CAPEX) of the fan low.

Initial Cost (CAPEX) and Operating Cost (OPEX)

Naturally, every end user would prefer to purchase the fan with the lowest CAPEX and OPEX for their installation. If the design criteria, ducting and installation considerations are satisfactory for an arrangement 8 fan, then generally an arrangement 8 fan has a lower CAPEX than an arrangement 7 or 3. But attention must be given to the differing manufacturer, industry and customer specifications. The specifications (or lack of specifications) can make a large difference in the OPEX of an arrangement 8 vs. 7 and 3. There are industry and customer specifications that give guidelines for the design of the rotor, but, very often, the fan manufacturer is asked to make the final suggestion on the arrangement. The OPEX for these differing arrangements usually comes down to the vibration sensitivity the rotor (how often and difficult it is to keep the fan balanced) and the life of the bearings (how often the end user has to change them).

It is very common to see specifications requiring a certain L10 (bearing life) for anti-friction roller bearings, but not very common to see a requirement on maximum bearing operating temperature and life cycle of the bearing lubricant. Both of these have a large effect on how often the bearing needs to be changed and how durable the fan is to poor maintenance. Some examples are given below:

Example 1: If you have an arrangement 8 fan that has a roller bearing L10 life of 50,000 hrs, an operating temperature of 185 deg F and a grease re-lube period of 25 days, these conditions could be deemed acceptable industry standards. But the same fan as an arrangement 7 fan with a roller bearing L10 life of 100,000 hrs, bearing operating temperature of 165 deg F and a re-lubrication period of 60 days, will have higher durability, reliability and the OPEX for the end user is lower because the bearings could last 2 to 3 times longer.

Example 2: Fans requiring sleeve bearings either due to a high fan thrust load or customer preference may require that the bearing next to the motor for an arrangement 8 fan, the drive end (DE) bearing to be cap loaded. This is not an ideal design situation for a sleeve bearing and may reduce the reliability of the fan depending on maintenance protocols.

Example 3: All rotating equipment has a vibration sensitivity level that is affected by temperature changes, impeller buildup/wear and aerodynamic disturbances in the fan. It is common for fan specifications to require fan balance grades and installed vibration levels. However, it is not common to specify rotor sensitivity levels. When comparing fan arrangements for the lowest OPEX, considerations should be given to how sensitive that fan arrangement will be in the long term to the conditions listed above.

Example 4: For a fan application requiring the housing to be gas tight and to operate at a very high speed (>1800 rpm). An arrangement 8 fan with a mono-block (tunnel) bearing would give a design that is easy to align, is very tolerate to unbalance loads and will only have one shaft seal to maintain.

The CAPEX consideration in deciding an arrangement consideration is straight forward by considering the initial cost of the fan, wiring and piping for bearing cooling options, shipping and handling, foundation, ducting and installation costs. The OPEX becomes more subjective in that the end user requirements, expectations and operating procedures play a big a part in the cost and their overall impression of the reliability of the fan.

REFERENCES

[1]AMCA Publication 201-02

ABOUT THE AUTHOR:

Steve Back is Director of Heavy Industrial Fans for The New York Blower Company. He has over 35 years of experience in the fan industry, working in a variety of areas.