Analysis of centrifugal Fan Impeller – A Review

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Abstract- *The following review paper shows the different analysis done by several researchers in the topic of centrifugal fan impellers when applied to different applications. The paper tries to investigate and analyse the internal relations between a large number of existing aerodynamic sketches and performance parameters of centrifugal fans. Moreover the effect due to fluid on centrifugal fan is shown. The details of flow mechanism with the variation of rotor blade lean angle at near stall conditions are presented in this paper. Commercial CFD code has been used to carry out all simulations.*

Keywords- Impeller , Whirl , Blade , Rotor, Stator, Centrifugal fan, CFD.

I. INTRODUCTION

Centrifugal fans are constant displacement devices or constant volume devices, meaning that, at a constant fan speed, a centrifugal fan will pump a constant volume of air rather than a constant mass. This means that the air velocity in a system is fixed even though mass flow rate through the fan is not. Centrifugal fans are not positive displacement devices. Centrifugal fans have certain advantages and disadvantages when contrasted with positive-displacement blowers.

In recent years, generating cost of power plants increases due to the shortage of coal. As important auxiliary equipment, fans consumed 30 percent of plant electrical consumption. So the study and optimization of centrifugal fan to improve the efficiency are important for the energy-saving of plant. Passage friction and flow separation causes impeller losses which are dependent on relative velocity, rate of diffusion and blade geometry. Impeller dynamic balancing usually is done on a precision balancing machine, because all energy of vibrational imbalance is lost

Total pressure and efficiency are important parameters of fan performance. In deduction of the energy equation for centrifugal fan, one of the assumption is that the impeller has unlimited blade. In fact, the blade number is always limited, which results in lower total pressure. Slip factor reflect the influence of limited blade on theoretical total pressure.

II. LITERATURE REVIEW ON IMPELLER

1) Songling WANG, Lei ZHANG, Zhengren WU Hongwei QIAN

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In this paper the author is narrating that Numerical simulation can accurately predict the performance of centrifugal fan and the details of the flow field in the fan. And it also has the important guiding significance in researching interior losses of centrifugal fans, optimizing impeller and modifying fan

(a)   (b)
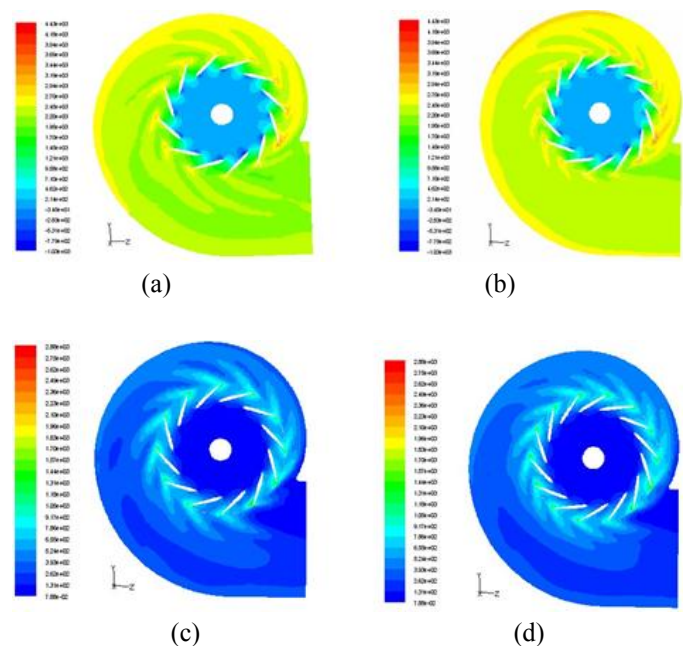
(c)   (d)

Figure 1. (a) Total pressure before optimization
(b) Total pressure after optimization
(c) Dynamic pressure before optimization
(d) Dynamic pressure after optimization

The total pressure and dynamic pressure distribution of volute section

Impeller optimization weakened the vortex intensity of secondary flow in volute, and reduced the energy loss caused by the secondary flow vortex and volute tongue of fan.

Through the optimization of blades number and impeller outlet setting angle, the energy loss in fan's impeller channel caused by wake current-jet and positive incidence angle was reduced.

(a)   (b)
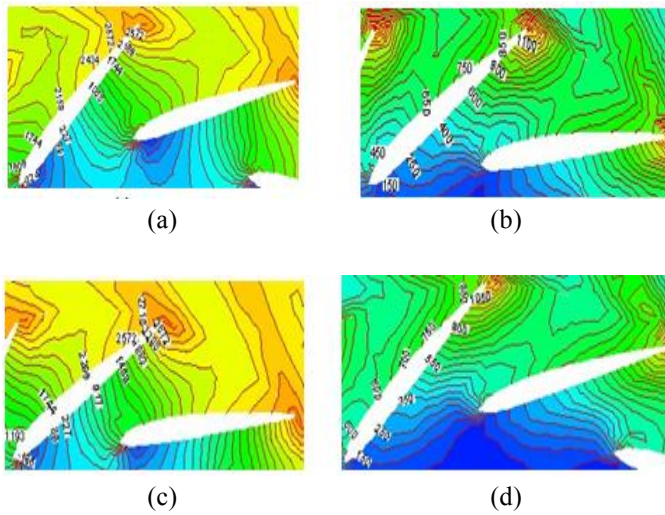

(c)   (d)

Figure 2. (a) Total pressure Distribution before optimization
(b) Dynamic pressure Distribution before optimization
(c) Total pressure Distribution after optimization
(d) Dynamic pressure Distribution after optimization

The total pressure and dynamic pressure distribution of impeller passage. The full pressure grows evenly along the circumferential direction before optimization. It can form a low pressure area at the front of the suction surface. And this indicates the existence of the positive attack angle, which causes the eddy-current in suction surface and the low energy region. After optimized, the full pressure of the flow grows evenly, and the area at the front of the suction surface decreases following the increase of the pressure. That thanks to the reduction of impeller outlet setting angle. Then the positive incidence angle and he eddy current loss of the suction surface reduced accordingly.

Figures (b) and (d) indicate the offset to pressure side of the dynamic pressure isocline in the middle flow channel. That caused by the different velocity between the pressure and suction surface in impeller channel, inducing uneven distribution of the dynamic pressure and current-jet flow structure in the channel outlet. After optimization the number of leaf blade increased, and enlarging the flow channel, narrowing the width and lengthen the acting time of vane to air current. At the same time, the reducing of the flow channel width cuts down the differential dynamic between the pressure and suction surface, bringing the dynamic pressure distribution more homogeneous and reducing energy loss caused by current-jet flow

Blade design

It shows the parts of centrifugal fan. Like inlet pipe, bell mouth, volute casing, outlet pipe, diffuser and the main part impeller.
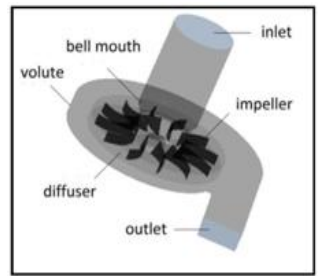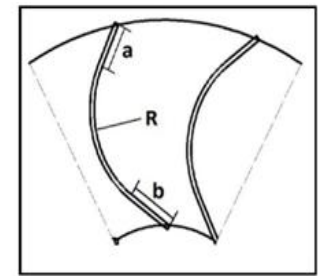

Figure 3. Fan model   Figure 4. Three main parts
                              of the Impeller blade

Model	A (mm)	B (mm)	R (mm)	L (mm)
Model 1	7	8.5	95	140.3
Model 2	14.1	16.8	80	144.6
Model 3	33.7	28.2	62	150.5
Model 4	39.8	40.3	50.7	147

Table 1.Dimensions of blade for Four Different Model

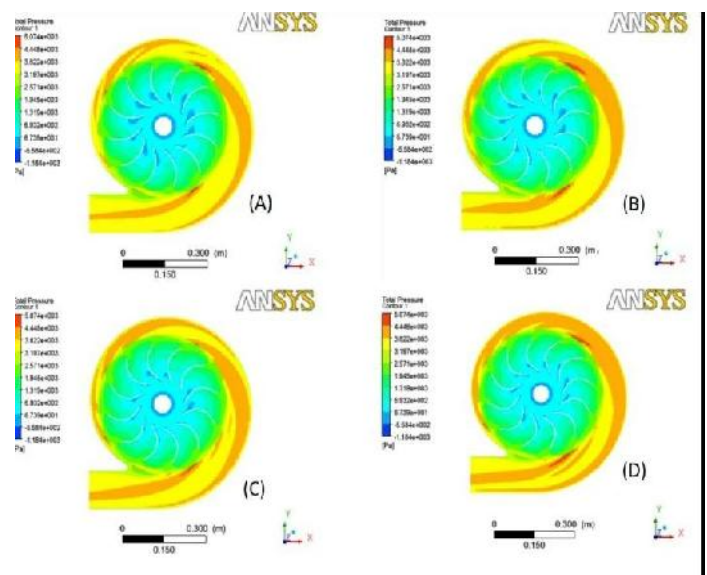| Inlet Diameter	150 mm
Outlet diameter	400 mm
Plate thickness	3 mm
Plate Shroud Diameter	400 mm
Plate thickness	4 mm
Shroud thickness	3 mm
Inlet Angle	30.98
Outlet angel	54.78

Table 2. Dimensions of Impellers

Figure 6. Shows the pressure level at mid plane. (For Model 1, model 2, model 3, model 4)

In this study the centrifugal fan was stimulated numerically to predict the effect of impeller blade shape on the fan performance and noise emitted.

Four models with different blade angles were designed. Three dimensional, steady state and transient flow was generated. Numerical results showed influence of changing curve length of the blade on performance and noise of the fan.

It was found that flow rates less than 0.4 kg/s the total efficiency increased with the increased blade lengths, but for the flow rates more than 0.4 kg/s the increasing of the increase in efficiency of Model 2 was better than Model 4. Same way we can conclude other quantities and their relevance to the given parameters.

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