Design of R.G Blower Grid Coupling

[1] Shanker Banothu, [2] Ajmeera Ramesh

Assistant Professor, CJITS, Jangaon.

Abstract: Our aim is to design a R.G Blower in which instead of the grid coupling, a bush pin coupling is used so as to reduce the degree of blower failures due to the failure of a coupling. By doing so the work labour and manpower is reduced to half the amount when used with a grid coupling.

The failure of the R.G. Blower occurs due to the failing of the coupling used in the blower. Presently Grid Coupling is used in the blower. A coupling is a device used to connect two shafts together at their ends for the purpose of transmitting power. Couplings do not normally allow disconnection of shafts during operation , however there are torque limiting couplings which can slip or disconnect when some torque limit is exceeded. The primary purpose of couplings is to join two pieces of rotating equipment while permitting some degree of misalignment or end movement or both. By careful selection, installation and maintenance of couplings, substantial savings can be made in reduced maintenance costs and downtime.

Key words: Grid coupling & Bush-pin coupling

1. Introduction

Titanium dioxide pigment (rutile) is the product, which is produced in the plant. The product is known by the name 'EMOX'. The titanium dioxide pigment is used mainly in paint industry. Asian paints are one of the major consumers of the product.

This process consist of the following steps

- Reduction and leaching of the raw ilmenite containing 55-60% TiO_2 to obtain beneficiated ilmenite of 90-92%
- Conversion of beneficiated ilmenite into TiO_2 pigment.
- Regeneration of spent HCl acid for the safe economy and pollution prevention.

R.G blower is the most critical rotating equipment in oxidation plant (U-300).If anything goes wrong in the blower , the whole stream has to take a shutdown.

production loss/Hr/stream is about is 1.2 lakhs.

Hence we feel that this failure analysis is of great importance as far as the company is concerned.

1.1 Specifications

Kind of fan	: recycle gas blower
Type of fan	: 33531/308
Manfacturer	: tlt engineering (india) pvt. Ltd. 64,g.i.d.c. industrial estate, phase-1 vatva , ahmadabad , 382 445.
Job	: 900106
Built in	: 1997
Location	: quilon
Manfacturing number	: 130
Sence of rotation (looking from motor end)	: c.w.

 ISBN : 978-81-925233-3-0

Volumetric flow rate	: 3.9 m^3/sec
Gas temperature	: 150°c
Total pressure rise	: 39777.0 pa
Temperature	
Inlet	- 1040c
Exit	- 1100c

Fig 1.Bushed pin flexible coupling

2. Design Procedure: Bush-Pin Coupling

a) Design for pins and rubber bush, b) Design for hub, c) Design for key, d) Design for flange

Calculation: N = 2980rpm P = 193.2KW

A. Design for pins (MS) and rubber bush:

We know that the mean torque transmitted by the shaft,

T mean= (P*60)/2πN = (193.2*1000*60)/2*π*960 =619.10*1000 N-mm

OD of shaft (d) = 75mm, Number of pins (n) = (d/25) +3, = (75/25) +3 =6

Diameter of pin (d_1) = (0.5*d)/$\sqrt{n}$ = (0.5*75)/$\sqrt{6}$

Diameter of pin=15.30mm≈24mm (std.value)

Overall diameter of rubber bush: d_2=24+2*2+2*6 =40mm

Diameter of pitch circle of pin: D1=2d+d_2+2*6 =2*75+40+2*6 =202mm

Assume allowable bearing pressure (Pb) for rubber bush=0.5N/mm^2

Length of rubber bush=L, W = Pb*d2*L, W = 0.5*40*L

Now max torque transmitted by the coupling: T = W*n*(D1/2), 619.1*1000 = 20*L*6*(202/2), L = 51mm

 ISBN : 978-81-925233-3-0

Now put it in (W): $W = 0.5*40*51$, $W = 1020$ N

Direct tension due to pure tension in coupling halves: $T = W/(\pi/4*24^2) = 1020/(\pi/4*24^2) = 2.25$ N/mm

Since the pin and rubber bush are not rigidly held in the left hand flange. Therefore the tangential load (W) at the enlarged portion will exert a bending action on the pin. Assuming a UDL along the bush ,the maximum bending moment of the pin (M)

$M = W(l/2+5) = 1020(51/2+5) = 31110$ N mm

Section modulus (Z) $=\pi/32*d_1^3 = \pi/32*24^3 = 1357.16$ mm^3

Bending stress (σ) $=M/Z = 31110/1357.16 = 22.92$ N/mm^2

Max principle stress $= \{(1/2)[\sigma+\sqrt{(\sigma+4\pi^2)}]\} = \{(1/2)[22.92\sqrt{(22.92^2+4*2.25^2)}]\} = 32.13$ N/mm^2

Max shear stress $= \{(1/2)[\sqrt{(\sigma^2+4\pi^2)}]\} = \{(1/2)[\sqrt{(22.92^2+4*2.25^2)}]\} = 18.67$ N/mm^2

Since the value of max principle stress for pin varies from 28 to 42 MPa, the design is safe.

B. Design of hub (CI):

Outer diameter of the shaft=75 mm

Length of the hub = 1.5*diameter=112.5mm

Outer diameter of the hub = 2*diameter, (D_H) =150 mm

Let us now check the induced shear stress for the hub material which is a cast iron considering hub as hollow shaft we know that maximum torque transmitted (T) is $619.1*10^3$

Induced shear stress(τ_c) , $619.1*10^3 = (\pi/16)*\tau_c*(D_h^4-d^4/D_h) = (\pi/16)*\tau_c*(150^4-75^4/150)$, $\tau_c=0.99$ N/mm^2 =0.99 MPa

Hence the induced shear stress for hub material is less than the permissible value of 15 MPa Hence the design of the hub is safe.

C. Design of sunk key (MS):

From the handbook for d=75 mm, width of key (w)=22 mm, Thickness of key=14 mm, Length of key=1.5*d =1.5*75 =112.5 mm

Let us now check the induce stress in key by considering it in shearing and crushing.

Consider the key is shearing: $T=1*w*\tau_k*(d/2)$, $619.1*1000=112.5\text{ mm}*22*\tau_k*(75/2)$, $\tau_k=6.67$ MPa

Considering the key is crushing: $T=L*(t/2)*\sigma_{ck}*(d/2)$, $619.1*1000=112.5*(14/2)*\sigma_{ck}*(75/2)$, $\sigma_c=20.96$ MPa

Therefore, both shearing and crushing stress in key are less than permissible shear of 40 MPa and 80 MPa respectively

Hence the design is safe

D. Design of flange (CI):

Thickness of flange (T_f) is taken as, T_f=0.5 d , =0.5*75 =35.7 mm

Check for the induced shear stress in flange

$T=\pi D_h^2/2*\tau_c*T_f$, $619.1*1000=\pi*(150^2/2)*\tau_c*37.5$, $\tau_c=0.467$ MPa

OD of flange (D2) = 4*dl=4*75=300 mm

Since the induced shear stress in the flange of cast iron is less than 15 MPa , the design of the flange is safe.

3. Maintenance Cost of RG Blower With Grid Coupling:

- Per hour shut down loss =Rs 1,25,000 /-
- Maintenance time for one RG blower = 4 hours
- Number of labourers required for changing RG blower = 2 people (Rs200/hr)
- Maintenance schedule for whole plant = 3
- Total time for the maintenance of RG blowers in whole plant = 4*3=12hours
- Total loss in shut down of whole maintenance of RG blowers in the plant =1,25,000*12 = Rs 15,00,000/-
- Labour cost for maintenance of coupling of RG blower per head =Rs200/-
- For two workers = 200*12*2 = Rs 4800/-

3.1. Maintenance Cost of RG Blower with Bush Pin Coupling:

Per hour shut down loss = Rs 1,25,000/-

Maintenance time for one RG blower = 2 hours

Number of labourers required for maintenance of a RG blower =2people (Rs 200/hr)

Maintenance schedule for whole plant = 3

Total time for maintenance for one RG blower in whole plant = 2*3=6hours

Total loss in shut down for maintenance of RG blowers in whole plant = 1,25,000*6 =7,50,000/-

Labour cost maintenance of RG blower for one worker = Rs 200/-

For two workers =200*6*2

= Rs 2400/-

Spare Parts List:

POS	PIECE	DENOMINATION	MATERIAL
1	1	Impeller ø1100	Ss 316
2	1	Shaft ø125*1090	Ck 316
3 u. 4	1	Block bearing assembly ø110/90- 500	div
3 a	1	Roller bearing	div
4 a	1	Ball bearing	div
5	1	Coupling type 212 FKN BIBBY MAKE	GG

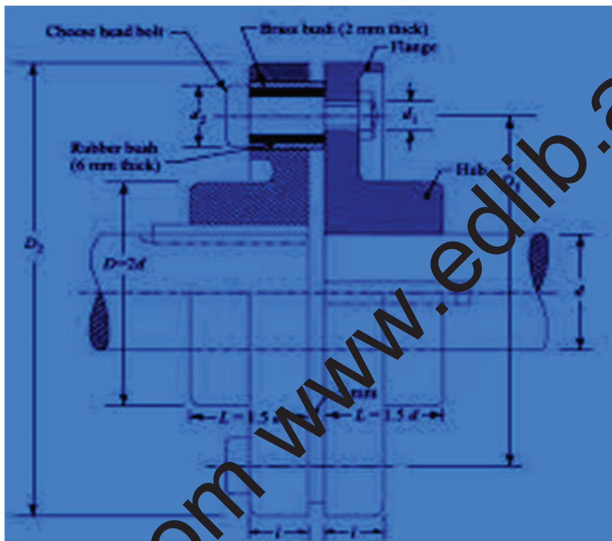

Fig. 2 Comparision between grid & bush-pin type coupling

4. Results

Saving from using bush pin coupling over grid coupling in RG blower =

(Maintenance cost of RG blower using grid coupling)- (Maintenance cost of RG blower using bush pin coupling)

=15, 00,000-7, 50,000

=Rs7, 50,000/-

Money saved in labour cost by using bush pin coupling over grid coupling

(Total labour cost of grid coupling RG blower)- (Total labour cost of bush pin coupling RG blower)

=4800-2400=Rs2400/-

5. Conclusion

The flexible coupling method of connecting rotating equipment is a vital and necessary technique. Large shaft in loosely mounted bearings, bolted together by flanged rigid couplings, do not provide for efficient and reliable mechanical power transmission. This is especially true in modern industrial's environment, where equipment system designers are demanding higher speeds, higher torques, greater flexibility, additional misalignment, and lighter weights for flexible couplings. The need of flexible coupling is becoming more acute as is the need for technological improvements in them. The basic function of a coupling is to transmit torque from the driver to driven piece of rotating equipment. Flexible couplings expand upon the basic function by also accommodating misalignment and end movement.

6. References

1. R.S. Khurmi , " A text book of machine design", EURASIA PUBLISHING HOUSE(PVT.) LTD., 14th edition
2. G.C. Pokrandt, "Steelflex[R]Coupling failure analysis", FLEX PUBLICTIONS, Second edition.
3. K.Mahadevan.R," DESIGN DATA BOOK", CBS PUBLISHERS, Third edition.
4. SCRIBD. RG-BLOWER
5. RG Series Engineering Guide.
6. Theory of Machines by Thomas Bevan, CBS.
7. Theory of Machines and Mechanisms-S.S.Rattan, Tata McGraw HillPublishers.
8. Theory of machines – PL. Ballaney, Khanna Publishers.

 ISBN : 978-81-925233-3-0