Prosedur Mendesain Sistem Ventilasi

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AGENDA PEMBAHASAN

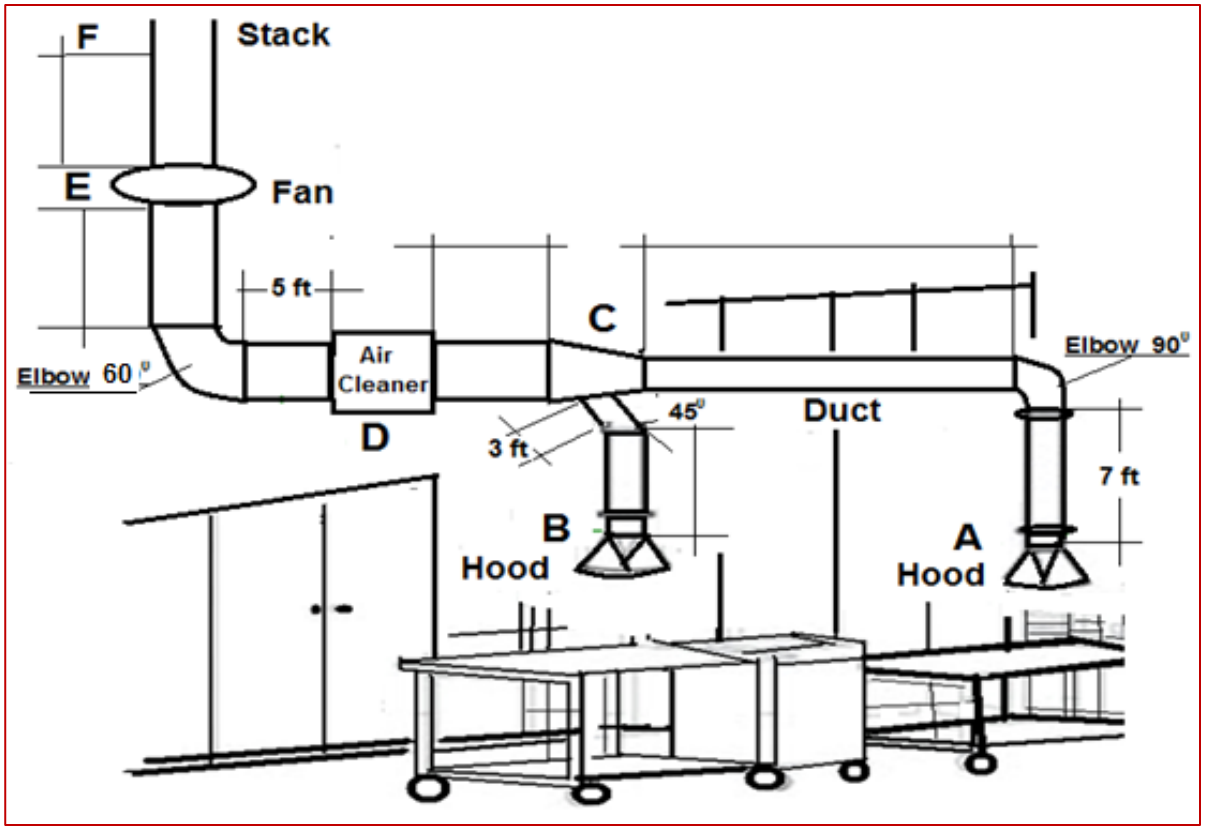
- Data awal desain
- Velocity Pressure Method Calculation Sheet
- Perhitungan Daya Fan

1.1 DATA AWAL

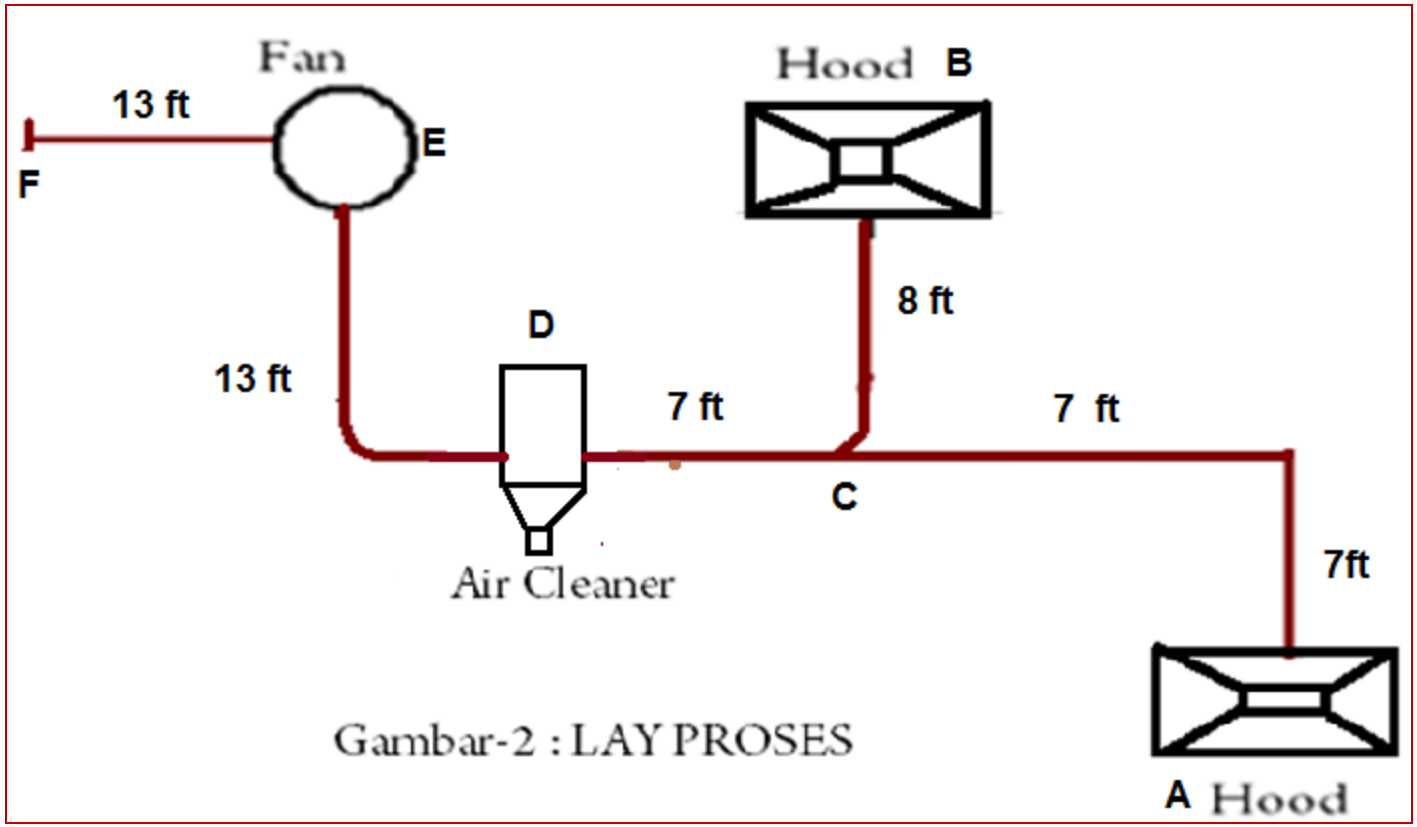
- Volume ruang (8 x 7 x 3 = 168 m^3) atau = 5.880 ft^3
- TLV = 2 fiber/cc
- Generation rate = 200 fiber/cc/60 menit
- Faktor K = 2
- Pengukuran kosentarasi polutan, dengan alat ukur
- Posisi pekerja dalam melakukan pekerjaan
- Maka, Volumetric flow rate, ------ Q = 19.600 cfm

1.2. BENTUK DAN LAY PROSES OPERASI RUANG KERJA

Pertimbangan desain sangat tergantung bentuk dan lay out proses operasi, ruang kerja dan bentuk kontruksi bangunan



Gambar -1 : BENTUK KONTRUKSI BANGUNAN



Gambar – 2 : SKEMA SISTEM SALURAN PIPA

2.2.. PENENTUAN DIMENSI

Dari data awal yang diketahui dan bentuk dan ukuran kontruksi bangunan pada gambar 1 dan gambar 2, maka ditetapkan sebagai berikut, pada table- 1.1.

Tabel- 1.1. Ukuran nomor detail, flow rate, diameter dan panjang pipa , elbow dan enteries

TABEL – 1.1

Nomor Detail	cfm Required	Duct Diameter inches	Panjang/ Strainght Run, ft	Elbows	Entries
A - C	19.600	26	14	1- 90^0	
B – C	19.600	24	8		1 - 45^0
C - D	19.600	32	7		
D (air cleaner)					
D -E	20.000	32	13	1-60^0	
E (fan)	20.000	21			
E - F	21.000	33	13		

II. PENENTUAN UKURAN –UKURAN UTAMA

2.1. PENENTUAN FLOW RATE SUPLAY (Q)

Untuk menghitung flow rate di gunakan rumus :

$$Q = \frac{\text{volume ruang x generation rate x K}}{\text{TLV}}$$

$$Q = \frac{(5.880 \times 200)/60 \times 2}{2}$$

$$Q = 19.600 \text{ cfm}$$

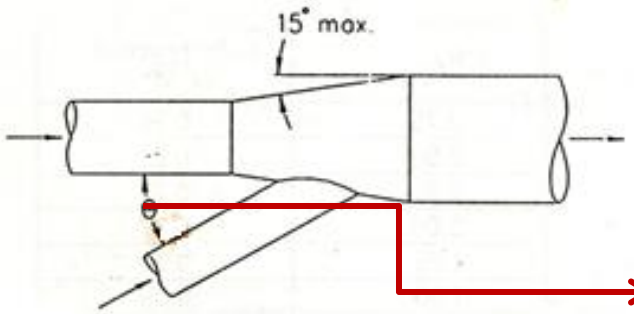
Dimana :

Volume ruang	=	5.880 ft^3
TLV	=	2 fiber/cc
Generatian rate	=	200 fiber/cc/60 menit
Faktor K	=	2

3.2. PEMELIHAN ALTERNATIF BRANCH ENTRY

Pemilihan alternative bentuk brach entry tergantung pada bentuk kontruksi, saluran pipa yang dinginkan , pada desain ini diambil bentuk prefered dengan sudut maximal $\theta = 45^0$, gambar 5.28 indutrial ventilation ACGIH edition 20. Ukuran data yang diambil seperti digambarkan pada Gambar – 6,

Nomor Detail	cfm Required	Duct Diameter inches	Panjang/ Strainght Run, ft	Elbows	Entries
B – C	19.600	24	8		$1 - 45^0$

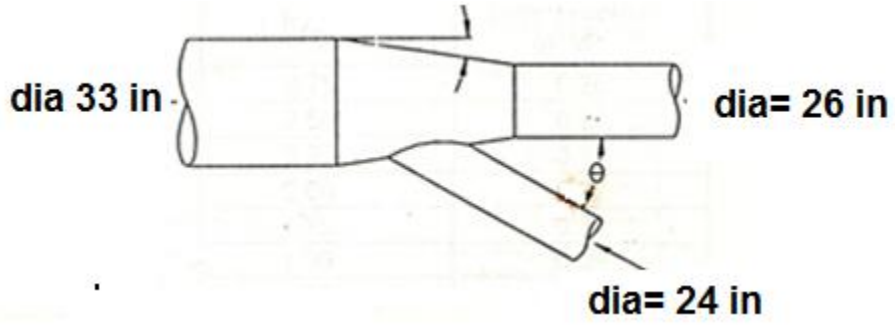


BRANCH ENTRY LOSSES

Angle θ Degrees	Loss Fraction of VP in Branch
10	0.06
15	0.09
20	0.12
25	0.15
30	0.18
35	0.21
40	0.25
45	0.28
50	0.32
60	0.44
90	1.00

III. DESAIN PROSEDUR

3.1. DESAIN DUCT



UKURAN	POTONGAN				
	A-C	B-C	C -D	D-E	E - F
Diameter (in)	26	24	32	32	33
Panjang (ft)	14	8	7	13	13

UKURAN	POTONGAN				
	Elbow	Bran Entri Loses	Loss friction		
A- C	1 -90^0	-	1,00		
B-C		1-45^0	0,50		
D-E	1-60^0	-	0,666		

IV. PERHITUNGAN

Metode perhitungan yang digunakan dalam desain ini adalah menggunakan metode desain Perhitungan Kecepatan Tekanan atau Velocity Pressure Method Calculation Sheet

4.1. METODE KECEPATAN TEKANAN

Dari hasil perhitungan yaitu untuk mengetahui distribusi volume flow rate, duct velocity, slot velocity, slot static pressure, hood static pressure, duct SP loss, dan qumulatif static pressure, Fan SP dan Fan TP.

Dengan data hasil perhitungan besar daya , dan putaran Fan yang akan digunakan.

4.1.1. Hasil Perhitungan

1	Duct Segment Identification			A-C	B-C	C-D	D	D-E	E	E-F
2	Target Volume Flowrate, Q = V*A- Chap 13		cfm	19600.0	19600.0	19600.0	21000.0	20000.0	20000.0	21000.0
3	Min. Transport Velocity, V Chap 13		fpm	3500	3500	3500		3500	3500	3500
4	Maximum Duct Diameter (D= ((4*144*Q)/(pi*V))		inches	32.05	32.05	32.05	A	32.38	32.38	33.18
5	Selected duct diameter		inches	26.00	24.00	32.00	I	32.00	21.00	33.00
6	Duct Area (pi*(D/12)^2/4)		sq. ft	3.6851	3.1400	5.5822	R	5.5822	2.4041	5.9366
7	Actual Duct Velocity		fpm	5318.7	6242.0	3511.1		3582.8	8319.3	3537.4
8	Duct Velocity Pres, VP = (V/4005)^2		"wg	1.7636	2.4291	0.7686	C	0.8003	4.3148	0.7801
9	H		Maximum Slot Area = (2/11)	sq ft				L			
10			Slot area selected	sq ft				E			
11	O	S	Slot Velocity, Vs Chap 13	fpm	400.00	400.00	400.00	A	400.00	F	400.00
12	O	L	Slot Velocity Pres, VPs=(Vs/4005)^2	"wg	0.0100	0.0100	0.0100	N	0.0100	A	0.0100
13	D	O	Slot Loss Coefficient - Chap 13, Chap 5		1.78	1.78	1.78	E	1.78	N	1.78
14		T	Acceleration Factor	0 or 1	0	0	0	R	0		0
15	S	S	Slot Loss per VP (13+14)		1.78	1.78	1.78		1.78		1.78
16	U		Slot Static Pressure (12*15)	"wg	0.0178	0.0178	0.0178		0.0178		0.0178
17	C	Duct Entry Loss Coefficient Chapter 13			0.250	0.250	0.250		0.250		0.250
18	T	Acceleration Factor (1 at hoods)		1 or 0	1	1	1		1		1
19	I	Duct Entry Loss per VP (17 + 18)			1.25	1.25	1.25		1.25		1.25
20	O	Duct Entry Loss (8 * 19)		"wg	2.204	3.036	0.961		1.000		0.975
21	N	Other Losses		"wg				0.400			
22		Hood Static Pressure SPh (16+20+21)		"wg	2.222	3.054	0.978	0.400	1.018		0.993
23	Straight Duct Length			ft	14.0	8.0	7.0		13.0		13.0
24	Friction Factor (Hf)				0.0070	0.0076	0.0056		0.0056		0.0054
25	Friction Loss per VP (23 * 24)				0.0982	0.0611	0.0394		0.0730		0.0704
26	No. of 90 degree Elbows (bottom of page)				1.00	0.50			0.67		
27	Elbow loss coefficient (bottom of page)				0.24	0.24	0.24		0.24		0.24
28	Elbow Loss per VP (26*Loss Factor)(bottom of page)				0.24	0.12	0.00		0.16		0.00
29	No. of branch entries			(1 or 0)	1.00	1.00	1.00		1.00		1.00
30	Entry loss coefficient				0.28	0.28	0.28		0.28		0.28
31	Entry Loss per VP (29*Loss Factor) (Branch)				0.28	0.28	0.28		0.28		0.28
32	Special Fittings Loss Factors										
33	Duct Loss per VP (25 + 28 + 31 + 32)				0.6182	0.4611	0.3194		0.5138		0.3504
34	Duct Loss (8*33)			"wg	1.0903	1.1201	0.2455		0.4112		0.2733
35	Duct Segment SP Loss (22 + 34)			"wg	3.313	4.174	1.224	0.400	1.429		1.266
36	Other losses			"wg							
37	Cumulative Static Pressure			"wg	-3.313	-4.174	-1.224	-0.400	-1.429		-1.266
38	Governing Static Pressure (at TO location)			"wg							
39	Corrected Volumetric Flowrate			cfm							
40	Corrected Velocity			fpm							
41	Corrected Velocity Pressure			"wg							
42	Resultant Velocity Pressure			"wg							

PERTINENT EQUATIONS:

Q corr.	=	Q Design (SP gov./ SP duct)^1/2
VP r	=	((Q1 + Q2)/(4005(A1 + A2)))^2
	=	(Q1/Q3)*VP1 + (Q2/Q3)*VP2
H f	=	0.0307(V^0.533)/(Q^0.612) = GALV in
	=	0.0425(V^0.465)/(Q^0.602) = BLK in Line 1a
FSP	=	SP outlet - SP inlet - VP inlet
Ce	=	Coefficient of Entry = (VP / SPh)
		1 (for perfect hood - No losses)
SPh	=	Hood Static Pressure = (V/4005)
VP	=	Velocity Pressure = SPh - he
he	=	Entry Loss = Fh x VP
TP	=	Total Pressure = SP + VP
SP; VP	=	Static Pressure; Velocity Pressure
Vd	=	Duct Velocity

90 Degree Round Elbow Loss Factors

R/ D	0. 5	0. 75	1	1. 5	2	2. 5
Stamped	0.71	0.33	0.22	0.15	0.13	0.12
5- Piece		0.46	0.33	0.24	0.19	0.17
4- Piece		0.5	0.37	0.27	0.24	0.23
3- Piece	0.9	0.54	0.42	0.34	0.33	0.33

60 elbow = 2/3 loss
45 elbow = 1/2 loss
30 elbow = 1/3 loss

Branch Entry Loss Factors	
Angle	Factor
15	0.09
30	0.18
45	0.28
60	0.44
90	1

No. of 90 degree Elbows (Contoh dalam perancangan,)

1-90^0 Elbow = 1,00 (ACGIH, figure 5-17)

60^0 Elbow = 0,6666 (ACGIH, figure 5-20, gbr.5.12)

45^0 Elbow = 0,50 (ACGIH, figure 5-20, gbr.5.12)

30^0 Elbow = 0,333 (ACGIH, figure 5-20, gbr.5.12)

V. PERHITUNGAN DAYA FAN

Data yang diperlukan untuk menentukan besarnya daya HP= House Power dan Putaran (rpm), Fan yang digunakan dalam desain ini adalah :

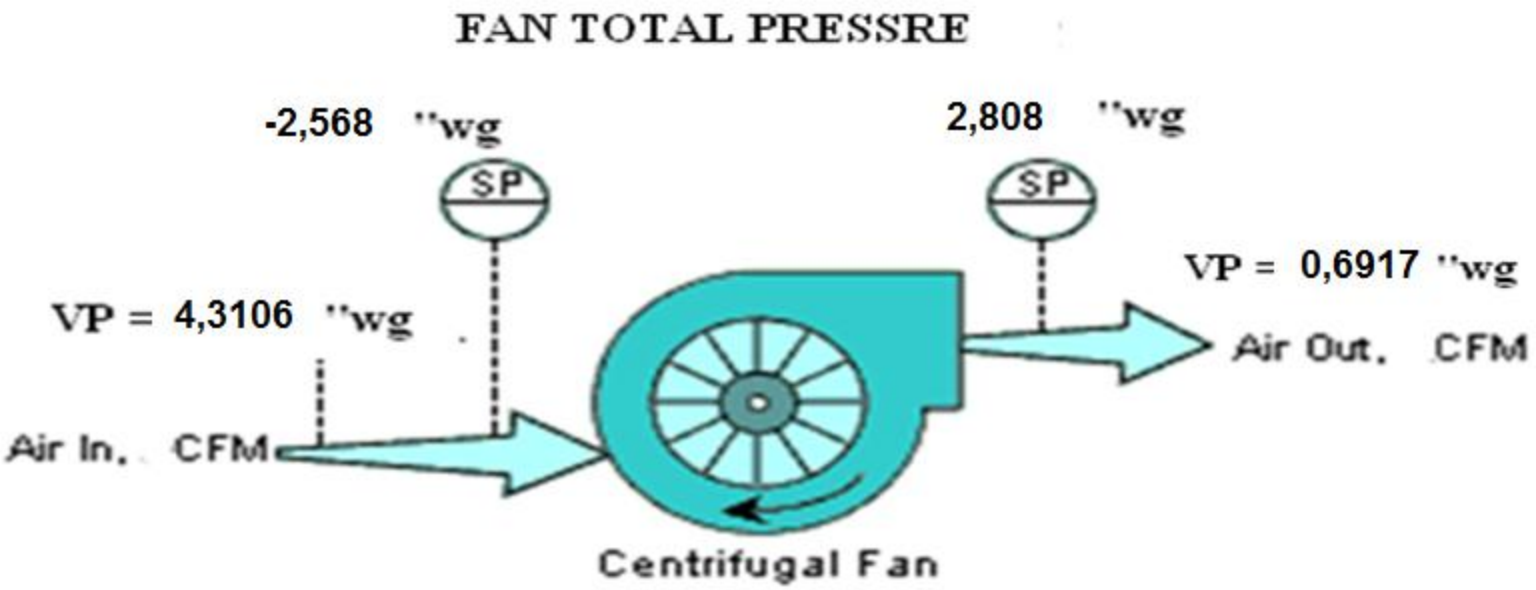
- ✓ N = jumlah blades,
- ✓ Q=volumemetric flow rate,
- ✓ FSP = Fan Static Pressure,
- ✓ FTP = Fan Total Pressure

Rumus yang digunakan sebagai berikut :

$FSP = SP_{out\ let} - SP_{in\ let} - VP_{inlet}$

$FTP = FSP + VP_{out\ let}$

$BHP = (FTP * Q)/(6356*n)$



FSP = Fan TP - VP_{out}

Fan TP = F SP + VP out
= 8.88 + 0.994
= 9.87 “wg

Dari data :
VP out = 0.6917 “wg

Dari hasil perhitungan pada hasil perhitungan dengan data sbb :

- $SP_{out\ let}$ = 2,808 “wg
- $SP_{in\ let}$ = - 2,568 “ wg
- $VP_{in\ let}$ = 4,3105 “wg
- $VP_{out\ let}$ = 0,6918 “wg
- Q =20.000 cfm

$FSP = SP_{out\ let} - SP_{in\ let} - VP_{inlet}$

FSP = 2,808 – (-2,568) – 4,3105

FSP = 1,066 “wg

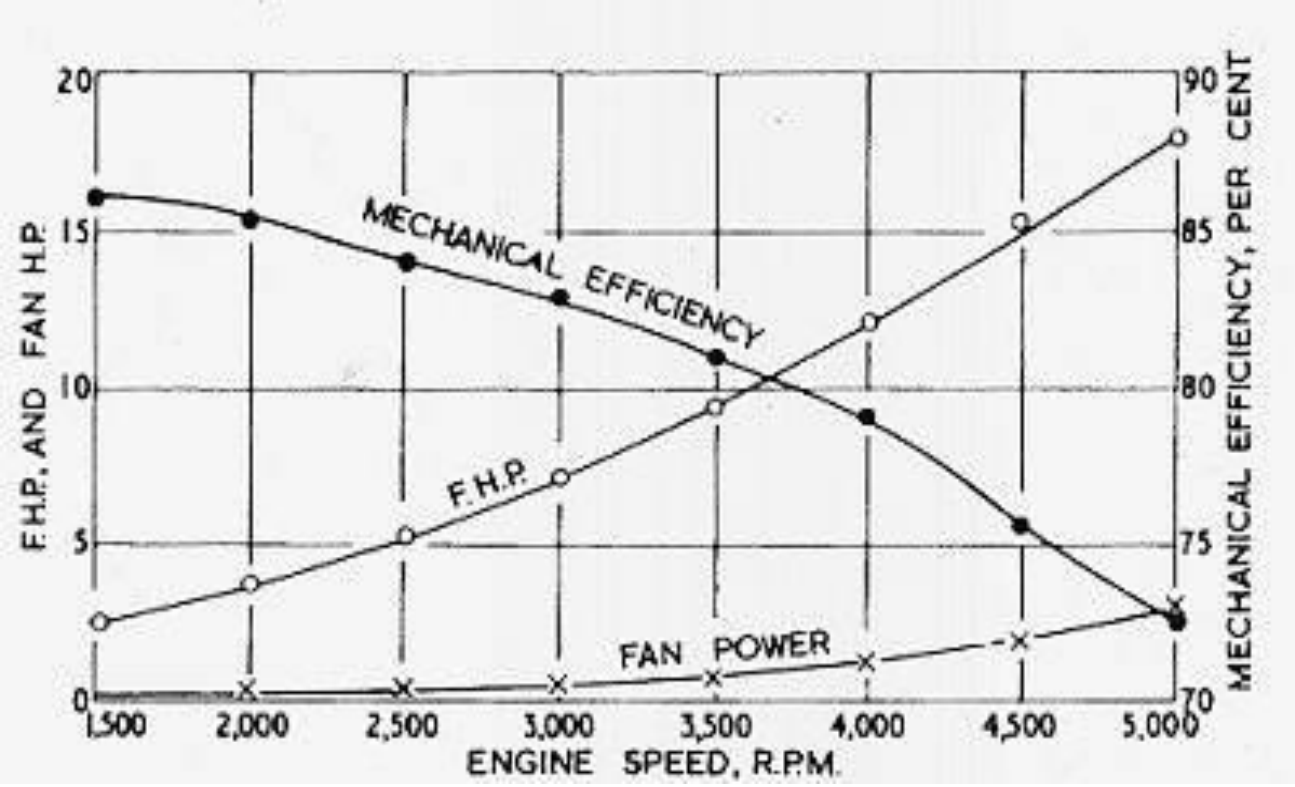
$FTP = FSP + VP_{out\ let}$

FTP = 1,066 + 0,6918

FTP =1,757 “wg

$$BHP = \frac{(1{,}757 \times 20.000) = 7{,}4}{(6356 \times 0{,}75)}$$

HP = 7,4 HP
RPM = 3.000



Fan Specifications		Existing		Required
Blade Type:				Tubeaxial
Size:		21		21
RPM:				3.000
HP:				**7.4**

Terima kasih &
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