

CI-**Energy Efficiency & De-carbonization in Pulp & Paper Industry**

By Anubhav Jha

S. No	Topic
1	About Danfoss
2	Drive Losses & Back Channel Cooling – Increase Efficiency in Drives Usage
3	One Drive for All motor Type – IM, PM, SynRM
4	Increase Life of Drives - Choose Conformal Coating

Danfoss Corporate HQ at Denmark

Danfoss Established in 1933
90 years of strong growth
Market Leader in core business



Danfoss Group...3 Business Segments



Danfoss Power Solutions

#2 Market position

- 7,826 employees
- 28 factories in 12 countries
- 2.2bn EUR annual sales



Danfoss Climate Solutions

#2 Market position

- 10,792 employees
- 32 factories in 15 countries
- 2.6bn EUR annual sales



Danfoss Drives

#2 Market position

- 4,504 employees
- 10 factories in 7 countries
- 1.5bn EUR annual sales



Danfoss India

Chennai Campus (on 50 acres land)

LEED Platinum rated campus with 10,000 trees around
4000 Employees, 75 Distributors



Research & Testing Facilities

Dedicated Drives lab with testing capacity up to 1MW

TEST BAYS

- Load test up to 1358 Amps @400 V
- Brake test up to 700kW

Certifications

- Bureau Veritas
- UL witness test data program



POWER ELECTRONICS LAB

- Low Voltage Directive
- Performance test
- UL 508C



ENVIRONMENT TEST CHAMBER

- IP test up to IP54

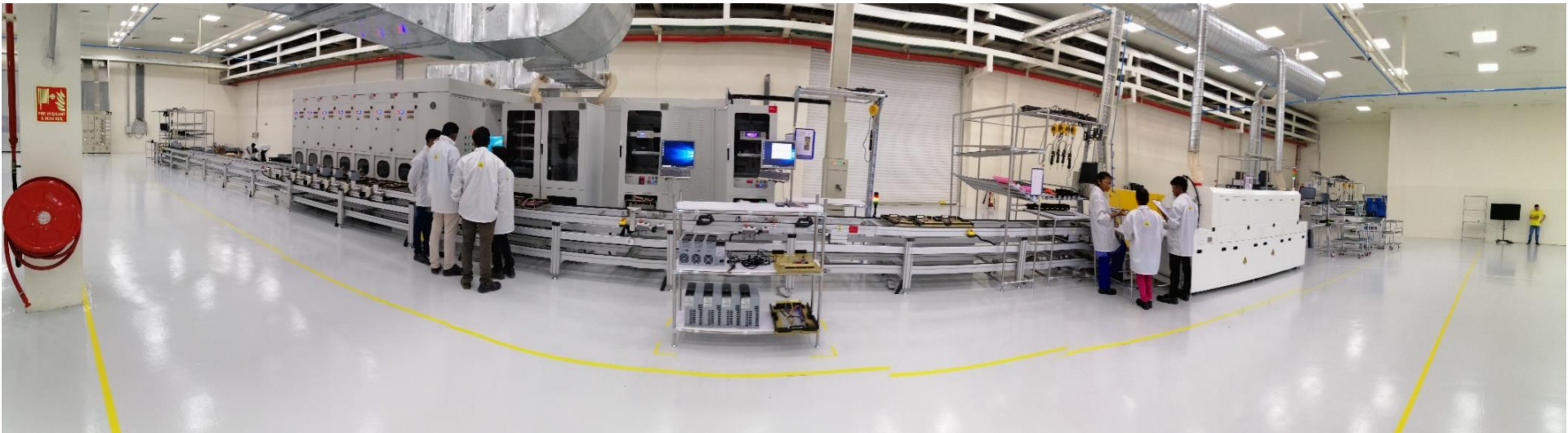


EMC TEST LAB

- EMC pre-compliance test – Conducted emission only



VFD Production line



Assembly-1

Assembly-2

Soldering and Coating

Hi-pot

IO

Burn-in

Packing

Engineering Center of Excellence

Solution for all Your Application needs

Danfoss Engineered Panel Solutions have proven their **market leadership with thousands of panel installations**. Our product line today includes **IP42, IP54, IP66 panels**.

Offers customized solutions to customers

- Designing and manufacturing of VFD panel **up to 2 MW**
- Capable of delivering up to **100 panels per month**
- **Full load test capacity up to 690VAC, 710KW**
- ISO 9001:2015 certified (To ensure stringent quality conformance)



Back Channel Cooling

**Increase Efficiency & Reliability in
Drive Systems**

Do we evaluate Losses in VFDs?

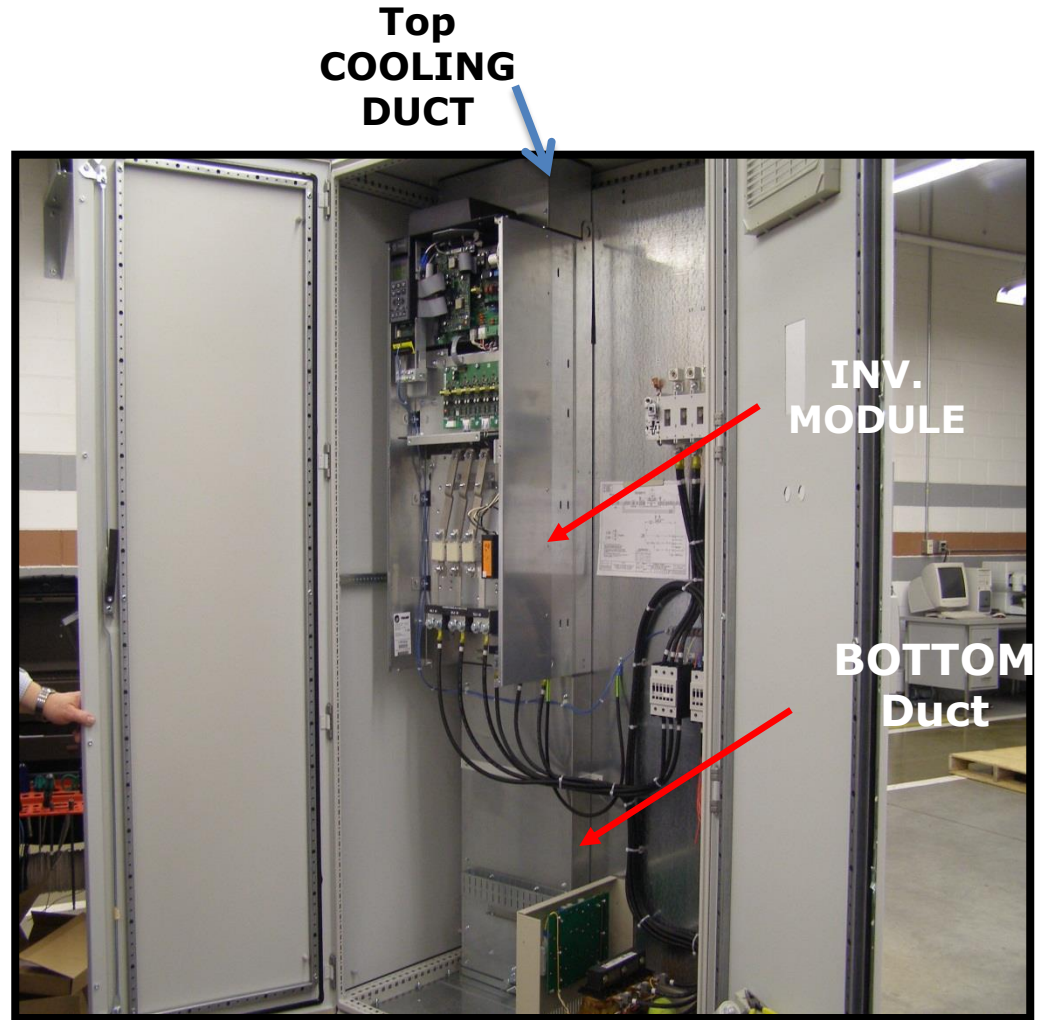
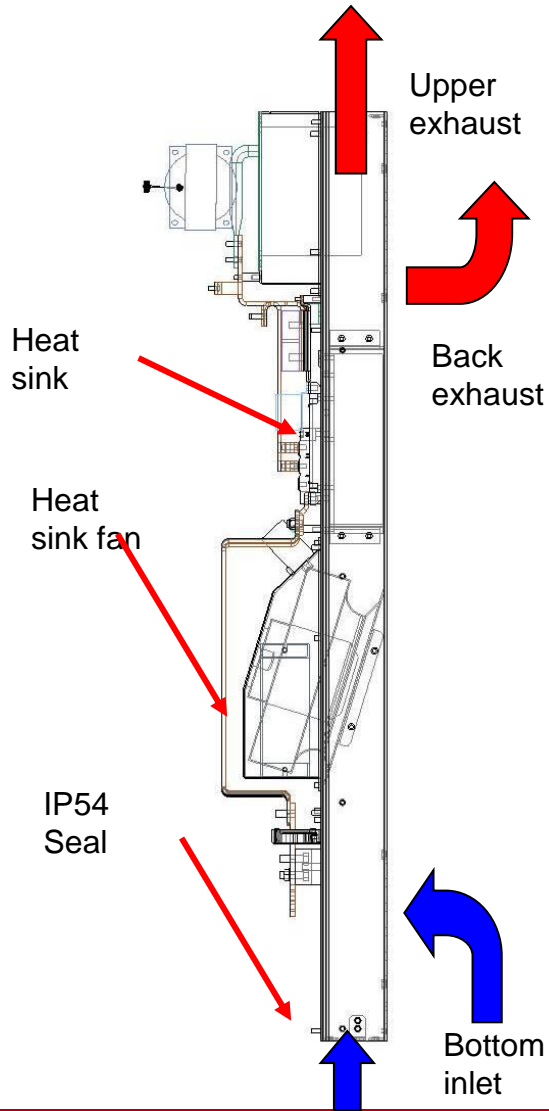
- Evaluate Actual Heat Losses in Drives instead of going by mere %Eff.
- In case of Air conditioning evaluate Running cost .
- 1Kw of Heat loss would need additional approx 0.34KW of Airconditioning Energy.
- This Helps to assess ,Cost of Ownership

Example

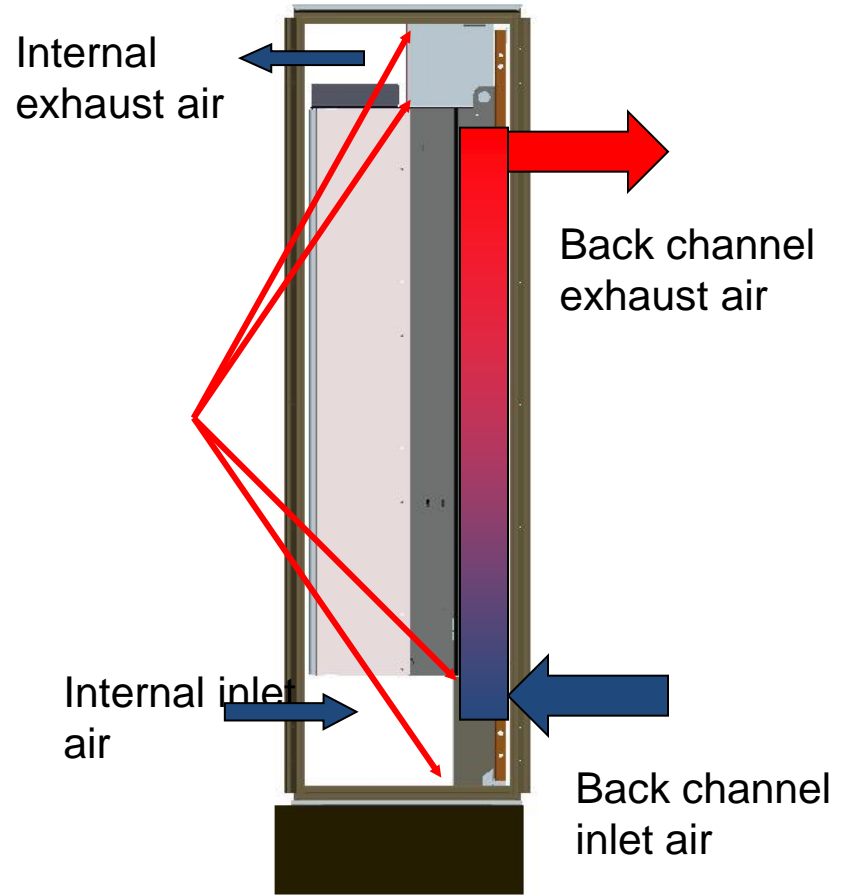
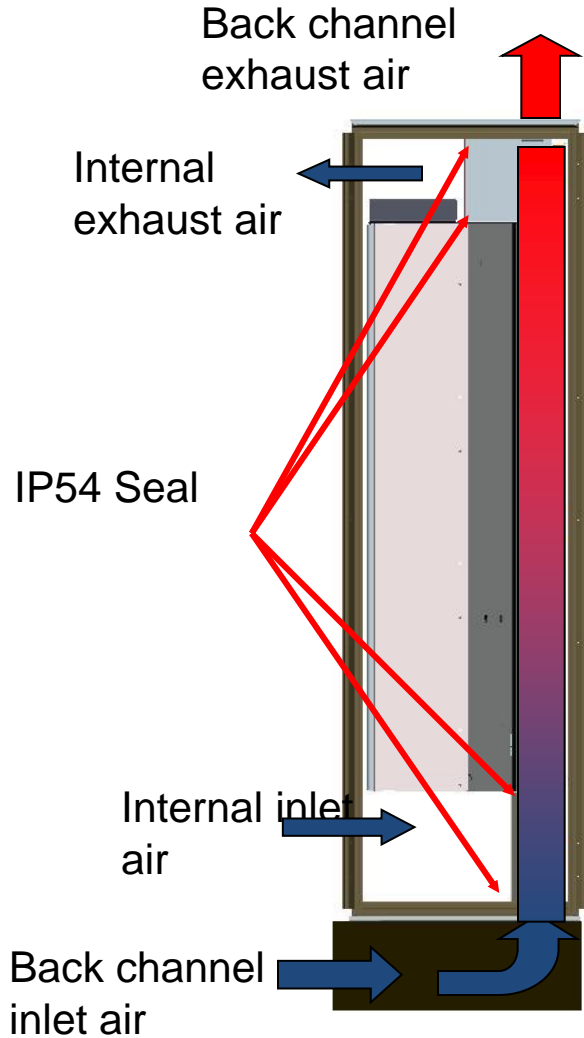
	Overload	HO	NO
Typical shaft output	[kW]	30	37
Estimated power loss at rated maximum load	[W]	570	698

Back Channel Cooling -

Reduce Air Conditioning Load by 85%



Back Channel Cooling-IP00/IP20 enclosure with back channel kits



Examples - Back Channel Cooling Benefits

**10Nos*
300Kw
Drives =
3000Kw**

**98% System
Efficiency =
60Kw Heat
Loss**

❑ Traditional case :

- 60kW need approximate 17 Ton of Air conditioning Load
- 17 Ton will consume = $0.34 \times 60\text{kW} = \mathbf{20\text{kW}}$

❑ Back Channel Cooling Case:

- 85% Losses/Heat is taken out of Room
- Only 15% Losses/Heat Need to be cooled
- $60\text{kW} \times 0.15 = 9\text{kW}$ Need approximate 2.5 Ton of Air conditioning Load
- 2.5 Ton will consume = $0.34 \times 9\text{kW} = \mathbf{3\text{kW}}$

- **OPEX You save ~ 17.0kW = Rs 8.5Lacs (1kW ~ Rs50K)/Annum**
- **CAPEX You save ~ 14.5Ton = Rs 4.2Lacs (1Ton ~ Rs30K)**
- **Maintenance You save Rs 14.5K (1Ton~1K annual)**
- **Power Saved 17kW, Decarbonization of 1.0Lac kG per Year**

Example

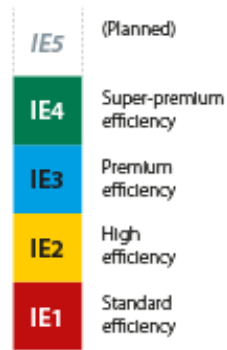
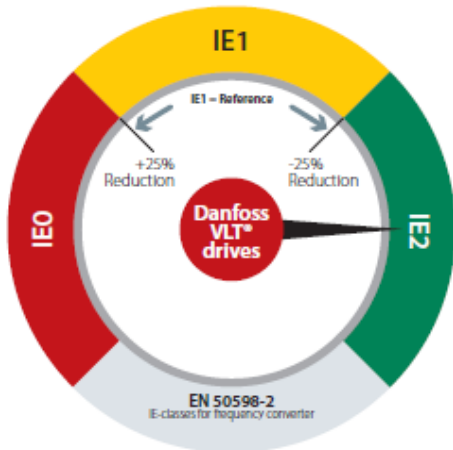


Example

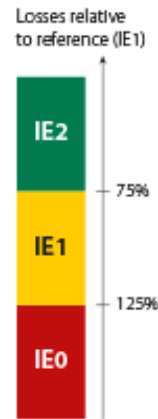


EN 50598 - 2

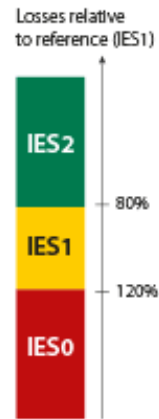
Defines Eff Classes for Frequency converters & Power Drive System (PDS) Motor-Freq converter combined system



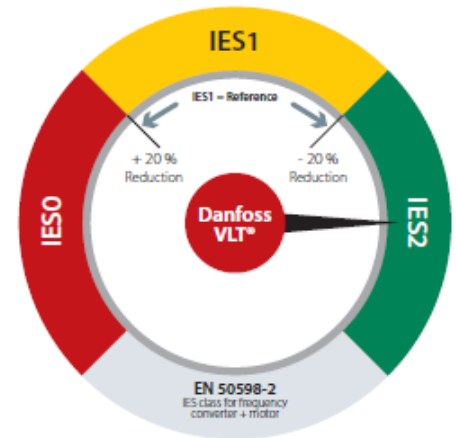
Motor
IEC/EN 60034-30-1
Defined at 100% motor speed and 100% torque



Frequency converter
EN 50598-2
Defined at 90% motor frequency and 100% current



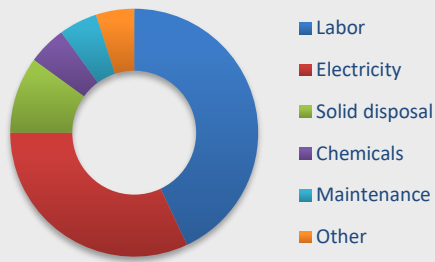
Motor-frequency converter system
Defined at 100% motor speed and 100% torque



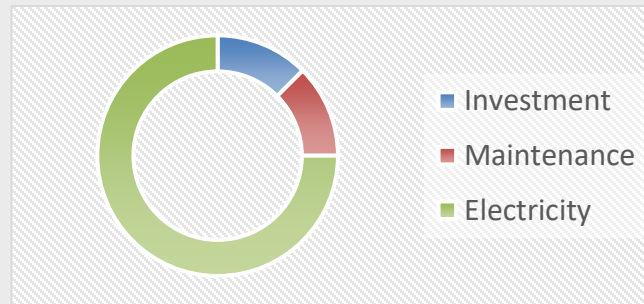
Energy-efficiency

High installed AC drive energy-efficiency is important

OPEX split

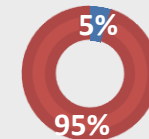


Blower CAPEX/OPEX split



Motor/AC drive CAPEX/OPEX split

Investment Electricity



Installed or 'wire to air' efficiency is the trend (ASME PTC 13)



Energy-efficiency

Which level of energy-efficiency difference is important?

IE efficiency classes for 4-pole motors at 50 Hz

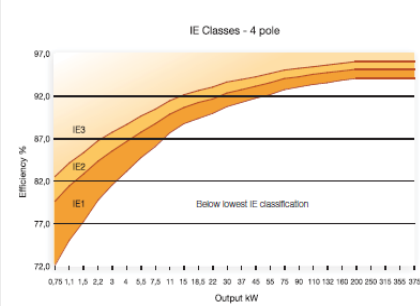
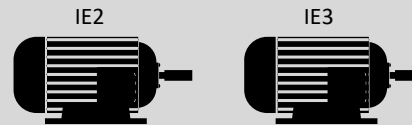


Table 1 Table with efficiency classes: IE 60054-30 (2008)

kW	HP	IE1 - Standard efficiency				IE2 - High efficiency				IE3 - Premium efficiency			
		2-pole	4-pole	6-pole	8-pole	2-pole	4-pole	6-pole	8-pole	2-pole	4-pole	6-pole	8-pole
0.37	0.5	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
0.55	0.75	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
0.75	1.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
1.1	1.5	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
1.5	2.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
2.2	3.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
3.0	4.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
4.0	5.5	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
5.5	7.5	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
7.5	10.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
10.0	13.5	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
13.5	18.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
18.0	24.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
24.0	32.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
32.0	43.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
43.0	58.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
58.0	78.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
78.0	105.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
105.0	140.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
140.0	190.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
190.0	260.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
260.0	350.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
350.0	470.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
470.0	630.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
630.0	850.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
850.0	1150.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
1150.0	1550.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
1550.0	2100.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
2100.0	2850.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
2850.0	3850.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
3850.0	5200.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0
5200.0	7000.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0



A 110 kW 50 Hz,
4 pole motor:

- IE 1 = 93.3%
- IE 2 = 94.5%
- IE 3 = 95.4%

For a 110kW motor,
the energy-efficiency
difference between
IE 2 vs IE 3 is 0.9%
but price difference is ~ +20%

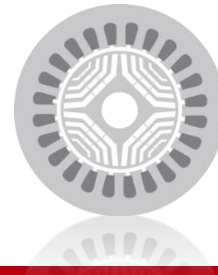
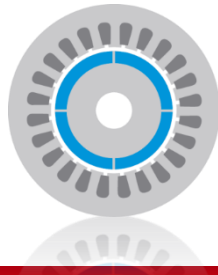
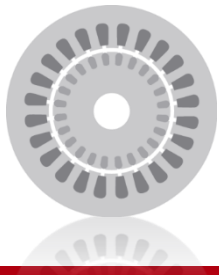
One VFD Drives All Motor Types



Freedom to Choose Motor Brand/Technology

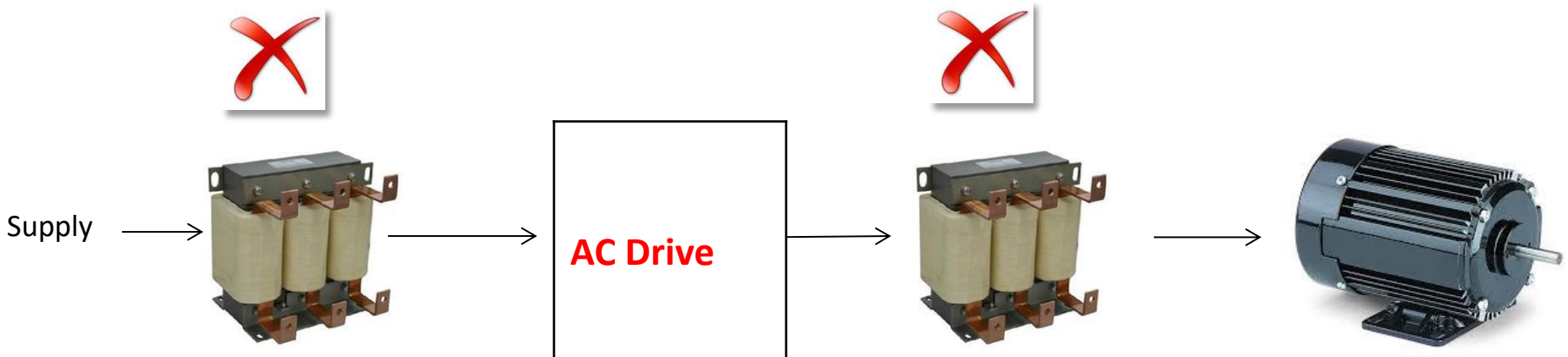
- One VFD can run all 3 Types of Motors.
- Core algorithm is Software Selectable
- Shift Motor Technology ,No need to change VFD
- No New spares Inventory
- Familiar VFDs, No New training Needed

1-10 Motor Construction		
Option:	Function:	
		Select the motor design type.
[0] *	Asynchron	For asynchronous motors.
[1]	PM, non salient SPM	For salient or non-salient PM motors. PM motors are divided into 2 groups, with either surface-mounted (non-salient) or interior (salient) magnets.
[3]	SynRM	



Consider Total Efficiency of System

- Choose Components which offer Best in class Efficiency to achieve Over all Best System Efficiency
- Evaluate and Avoid Unwanted Components



$$\eta_{\text{Total}} = \eta_{\text{Inputchoke}} \times \eta_{\text{Drive}} \times \eta_{\text{outputchoke}} \times \eta_{\text{Motor}}$$

Conformal Coating

Some Corrosive Chemicals in Industries

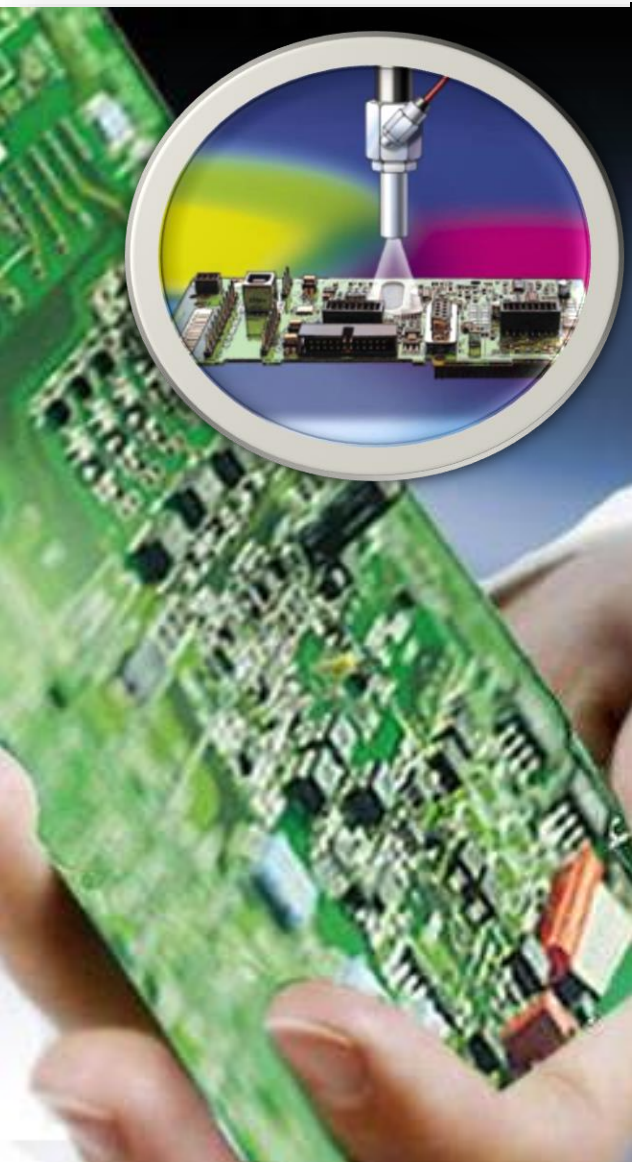
Application	Constituent	Symbol
Sewage plants	Ammonia	NH_3
	Hydrogen sulphide	H_2S
	Active organic nitrogen	N_2
Paper mills and wood pulping	Hydrogen sulphide	H_2S
	Carbon monoxide	CO
	Chlorine's	Cl, Cl_2
	Active organic nitrogen	N_2
Water treatment	Hydrocarbons	C_n, H_n
	Hydrocarbons	C_n, H_n
Combustion of fossil fuels/automotive emissions	Hydrogen sulphide	H_2S
	Sulphur dioxide	SO_2, SO_3
	Nitrogen oxides	NO_x
	Carbon monoxide	CO

Sulphuric acid manufacture	Hydrogen Chloride Hydrocarbons	HCL C_n, H_n
Fertilizer manufacture	Hydrogen fluoride Ammonia	HF NH_3
Steel manufacture and ore smelting	Hydrogen fluoride Hydrogen sulphide Sulphur dioxide	HF H_2S SO_2, SO_3
Aluminium manufacture	Hydrogen fluoride Chlorine's	HF Cl, Cl_2
Foundries	Mercaptans Carbon	$\text{S}_B, \text{R-SH}$ C
Cleaning of products	Ammonia Chlorine's	NH_3 Cl, Cl_2

Different constituents attack metals,

- e.g, Sulphur Di-Oxide attacks all metals except Noble metals
- Nitrogen, Ammonia and Ammonia Salts attack copper and brass
- Hydrogen Sulphide attacks Silver and copper

EASY. **RELIABLE.** FLEXIBLE.



■ **Premature Failure Prevention**

- Class 3C3 conformal coated PCBs as standard increases lifetime & reliability of drives in harsh environments
- Protects against environmental pollution, moisture, and dust
- No premature failure of drives due to harsh environment

EASY. **RELIABLE.** FLEXIBLE.



IEC61-721-3-3 Classifications



Environment Parameter	Unit	Class				
		3C1	3C2		3C3	
			Mean value	Max value	Mean value	Max value
Sea salt	mg/m ³	No	Salt mist		Salt mist	
Sulphur dioxide	mg/m ³	0,1	0,3	1,0	5,0	10
Hydrogen Sulphide	mg/m ³	0,01	0,1	0,5	3,0	10
Chlorine	mg/m ³	0,01	0,1	0,3	0,3	1,0
Hydrogen Chloride	mg/m ³	0,01	0,1	0,5	1,0	5,0
Hydrogen Fluoride	mg/m ³	0,003	0,01	0,03	0,1	2,0
Ammonia	mg/m ³	0,3	1,0	3,0	10	35
Ozone	mg/m ³	0,01	0,05	0,1	0,1	0,3
Nitrogen Oxides	mg/m ³	0,1	0,5	1,0	3,0	9,0



ENGINEERING
TOMORROW