WHAT IS AN FAN? TEST BOUNDARY? TEST METHOD?

EU FAN REGULATION 327/211 REVIEW, EU COMMISSION

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- TEST BOUNDARIES? TEST METHOD?
- TESTING AXIAL IMPELLER PERFORMANCE
- CASING BOUNDARY ISSUE EXAMPLES
- THE IMPLEMENTING MEASURES OF 2009/125/EC
- BEST EFFICIENCY POINT VS ACTUAL OPERATING POINT
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WHAT IS A FAN?

- EN ISO 13349:2010 FAN – VOCABULARY AND DEFINITIONS OF CATEGORIES
  - 3.1.1 **fan**: rotary-bladed machine that receives mechanical energy and utilizes it by means of one or more impellers fitted with blade blades to maintain a continues flow of air or other gas passing through it and whose work per unit mass do not normally exceed 25 kJ/kg
  - 3.1.2 **bare shaft fan**: fan without drives, attachments or appurtenances
  - 3.1.3 **driven fan**: **impeller** fitted to or connected to a motor, **with or without** a drive mechanism, a housing or a means of variable speed drive
  - 3.6.9 **plug fan**: fan having an unhoused impeller arranged such that the system into which it is inserted acts as a housing, allowing air to be drawn into the impeller inlet
  - 3.6.10 **plenum fan**: fan having an unhoused centrifugal impeller which draws air into the impeller through an inlet located in a barrier wall, and having a driver located on the same side of the barrier as the impeller

- ISO 12759:2010 FANS – EFFICIENCY CLASSIFICATION FOR FANS
  - 3.1.1 **fan**: Same as ISO 13349
  - 3.1.2 **bare shaft fan**: fan without drives, attachments or accessories (appurtenance)
  - 3.1.3 **driven fan**: one or more **impellers** .. Rest the same as ISO 13349

WHAT IS A FAN?

- COMMISSION REGULATION (EU) 327/2011Article 2 Definitions
  - 1 **fan**: means a rotary bladed machine that is used to maintain a continues flow of gas, typically air, passing through it and whose work per unit mass do not exceed 25 kJ/kg, and which:
    - Is designed for use with or equipped with an electrical motor with an electric input power between 125W and 500 kW (>= 125W and <= 500 kW) to drive the impeller at its optimum energy efficiency point
    - Is an axial fan, centrifugal fan, cross flow fan or mixed flow fan,
    - May or may not be equipped with a motor when placed on the market or put into service
  - 2 **impeller** means the part of the fan what is imparting energy into the gas flow and is also known as the fan wheel;
  - 3 **"Axial fan"** means a fan that propels gas in the direction axial to the rotational axis of one or more impeller(s) with a swirling tangential motion created by the rotating impeller(s). The axial fan may or may not be equipped with a cylindrical housing, inlet or outlet guide vanes or an orifice panel or orifice ring;
  - 12 "**Housing"**: means a casing around the impeller which guides the gas stream towards, through and from the impeller

- COMMISSION REGULATION (EU) 327/2011ANNEX II MEASUREMENTS & CALCULATIONS

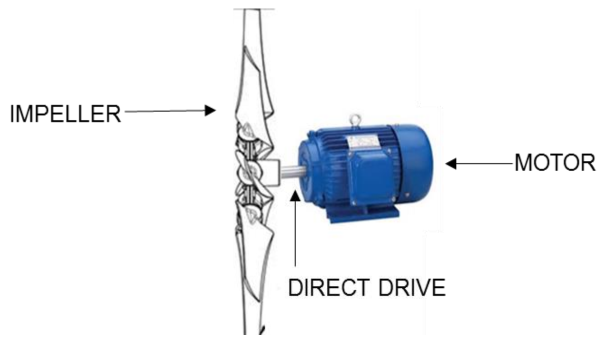
  - (5) "Final assembly" means a finished or assembled on-site assembly of a fan that contains all the elements to covert electric energy into fan gas power without the need to add more parts or components

  - (6) "Not final assembly" means an assembly of fan parts, consisting of at least the impeller, which needs one or more externally supplied components in order to be able to convert electric energy into fan gas power

WHAT IS A FAN?

- That means an axial fan may be:

Impeller



Motor

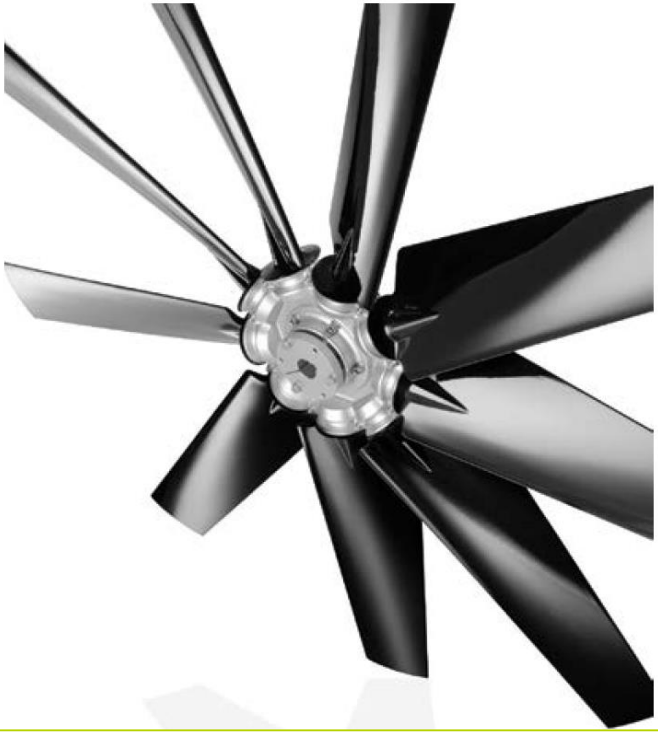
Impeller

Fitted to a motor
Designed for use with an electrical motor

Housing

WHAT IS A FAN?

- Flexible axial impellers



“Flexible” means fan impellers tailored to customers’ specific operating points and conditions by the option to change:

- Blade profile
- Impeller diameter - mm by mm
- Number of blades
- Blade pitch
- Direction of rotation
- Mounting configuration

This means an opportunity to improve overall system efficiency.

“System efficiency efficiency may be optimized though an iterative process with axial impellers that covers:

1. Selecting different axial impeller prototypes
2. Adjusting integrated axial impellers
3. Testing & comparing the performance on the final functionality

TEST BOUNDARIES? TEST METHOD?

Study for the Review of Fan Regulation 327/2011

European Commission

Contact

Project leader:
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Assistant researcher:
Roy van den Boorn (e-mail: r.van.den.boorn@vhk.nl

What's new?

Date	Subject
31 October 2014	Minutes of the first stakeholder meeting are now available

RK asks how far the standardisation groups are on the definition of 'fan' (and in particular 'fan housing for testing' in cases where there is a suboptimal fan housing geometry due to other functionality considerations in the end product) but at this point there is no reaction from the meeting. The study team is waiting for written input on the subject.

http://www.fanreview.eu/

TEST BOUNDARIES? TEST METHOD?

SITUATIONS WHERE A FAN MAY BE PLACED ON THE MARKET/SOLD TO THE FINAL CUSTOMER				
Fan Parts & Spare Parts	Driven Fan		Integrated Driven Fan	
Impeller  Impeller MUST be fitted to a motor/designed for use with an electrical motor	**Housed driven impeller** 	**Unhoused driven impeller** 	**Non Fan product with driven unhoused impellers integrated** 	
MODE OF FAN SUPPLY SITUATIONS				
Unhoused impeller fitted to an electrical motor is supplied as “not final assembly”	Housed impeller is supplied as “final assembly”	Unhoused impeller is supplied as “final assembly”	Both housed and unhoused impeller supplied to the integrator as “final assembly”	Both housed and unhoused impeller is supplied to the integrator as “not final assembly”

TEST BOUNDARIES? TEST METHOD?

SITUATIONS WHERE A FAN MAY BE PLACED ON THE MARKET/SOLD TO THE FINAL CUSTOMER				
Fan Parts & Spare Parts	Driven Fan		Integrated Driven Fan	
MODE OF FAN SUPPLY SITUATIONS AND FAN TEST BOUNDARY (X)*				
Unhoused impeller fitted to an electrical motor is supplied as "not final assembly" and measured based upon the upon the suppliers defined housing test-setup (A)*	Housed impeller is supplied as "final assembly" and measured as an complete unit (B)*	Unhoused impeller is supplied as "final assembly" and measured as an complete unit based upon the suppliers defined housing test-setup (C)*	Housed and unhoused impeller supplied to the integrator as "final assembly" and measured as (B)* and (C)*, respectively.	Housed and unhoused impeller is supplied to the integrator as "not final assembly" and measured based upon the housing set-up as supplied (E)* and the suppliers defined test-setup (A)*, respectively.
CALCULATION METHOD				
Overall efficiency calculated by multiplying measured impeller efficiency with remaining component efficiencies C.f. ISO 12759 Annex B & 327/2011 Annex II	Overall efficiency calculated by dividing measured fan gas power with measured input power C.f. ISO 12759 5.3.4/5 & 327/2011 Annex II	Overall efficiency calculated by dividing measured fan gas power with measured input power C.f. ISO 12759 5.3.4/5 & 327/2011 Annex II	Overall efficiency calculated by dividing measured fan gas power with measured input power C.f. ISO 12759 5.3.4/5 & 327/2011 Annex II	Overall efficiency calculated by multiplying measured impeller efficiency with remaining component efficiencies C.f. ISO 12759 Annex B & 327/2011 Annex II
				Actual values of other components shall preferable be used instead of default values c.f. ISO 12759 B.1 Important to use the motor efficiency at actual absorbed power c.f. ISO 12759 D.2.5

TEST BOUNDARIES? TEST METHOD?

- ISO 12759:2010 FANS – EFFICIENCY CLASSIFICATION FOR FANS
  - **B.1 General**:
    - The efficiency of the drive and components, which are not included in the scope of delivery, can only be estimated
    - The estimated efficiency values can either be those certified by the manufacturers of suitable and commercially available components or be the default values listed in this annex.
    - To encourage the improvement of the efficiency of the components offered as complement to bare shaft fans, actual efficiency values provided by component manufacturers shall preferable be used instead of default values
  - **D.2.5 Motor power**
    - … The efficiency for actual motors at partial loads (around 75% of nameplate rating) can sometimes be greater that at full load. This is contrary earlier designs. It is important to use the efficiency at the actual absorbed power, which may be calculated using any of the methods described in IEC 60034-2-1.

TESTING AXIAL IMPELLER PERFORMANCE

"Its not possible to test the performance of fan impellers"

NOT TRUE – Multi-Wing and other Fan impeller manufacturers are doing this daily and Multi-Wing has been doing this for quite a few years. What is true is that no complete fan impeller standard exists that for example compliance authorities may follow. However, Multi-Wing has been awarded the opportunity to develop an proposal for an CEN standard that elaborates on that before primo December 2014. In addition, an similar opportunity has been expressed by AMCA.

TESTING AXIAL IMPELLER PERFORMANCE

1. General Testing Requirements

The performance of impeller is experimentally determined on a test setup that conforms to AMCA 210 and ISO 5801. The test setup is a type A inlet chamber configuration.

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DRAFT PROPSAL PLANNED FOR SUBMISSION TO CEN/TC 156 WG 17 BEFORE NEXT MEETING

TESTING AXIAL IMPELLER PERFORMANCE

Proposal send to AMCA International

For the purpose of this regulation, axial Impeller performance certification based on a defined test setup in accordance with ____ may be used in lieu of fan performance certification when an axial impeller is integrated into the housing of a non-fan product. Axial impeller certification may not be used in lieu of fan performance certification if the impeller is used in and sold as part of a stand-alone fan.

CASING BOUNDARY ISSUES

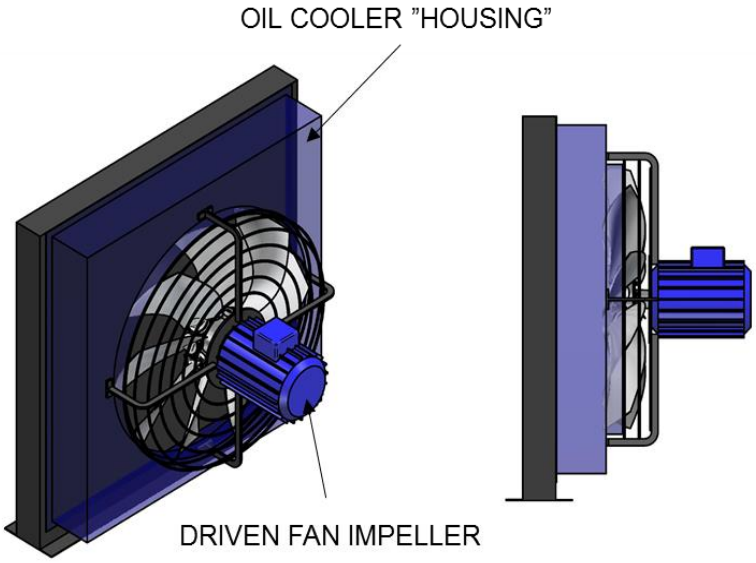
"Fans and fan impellers must be tested as integrated in all cases"

- **NOT TRUE** – Its required that the environmental performance can be assessed independently and that there shall be no negative impact on the functionality of the product, from the perspective of the user

"ECODESIGN Directive implies that integrators must change their product design if for example current "integrated housing" and tip clearances makes it impossible to reach the ErP requirements or that impeller manufactures must develop better fan impellers."

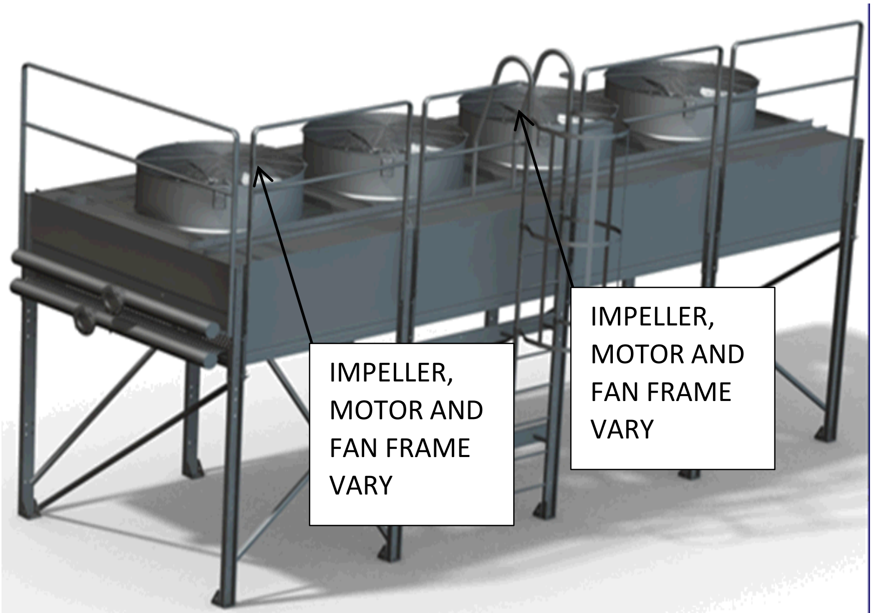
- **NOT TRUE** – The legal text of 327/2011 and any other "implementing measure"/regulation is adopted on a case by case basis for each product group. The implication of the statement is that 327/2011/The EU Fan Regulation should be an "super regulation" cutting across all product groups where its integrated and where there has been no working plan, no background study and no stakeholder process and where the requirement for implementing measures has not been assessed. Obviously, that can not be the case.

CASING BOUNDARY ISSUES – OIL COOLER



In this application, a fan impeller blower is adjusted and integrated into a heat exchanger to ensure best possible cooling performance and efficiency. The shroud of the radiator is simultaneous the shroud of the fan, it is one part. The fan unit is integrated into the system. Due to the design and space restrictions, there is no space for complete fan units with bell mouth and smooth edges, which would be best for optimizing the relation between input power and fan gas power. In addition, to reach the best efficiency in cooling the inlet is shaped/designed to deliver an air distribution across the entire radiator surface. This makes it impossible to create a heat exchanger, which acts as a ventilator towards optimal fan efficiency. Obviously, the application is not optimized for the same purpose as a ventilator but for cooling a medium down for any application or process.

CASING BOUNDARY ISSUES – Industrial cooling and condensing



"The cooling capacity can be significantly negatively impacted.

This is because of the required air distribution to maximize cooling power in a unit is different from the requirement to maximize ventilation fan efficiency. Secondary, and change in "housing design" will make it unfit for incorporation into a wide range of applications. These changes will influence all the way through the value chain: Main users are power, food, process, oil&gas and mining industry. The units are utilized in a wide range of applications, e.g. in diesel and gas engine power plants for cooling , DH-networks for cooling, biomass power plants for cooling, turbine oil cooling, petrochemical processes for condensing"

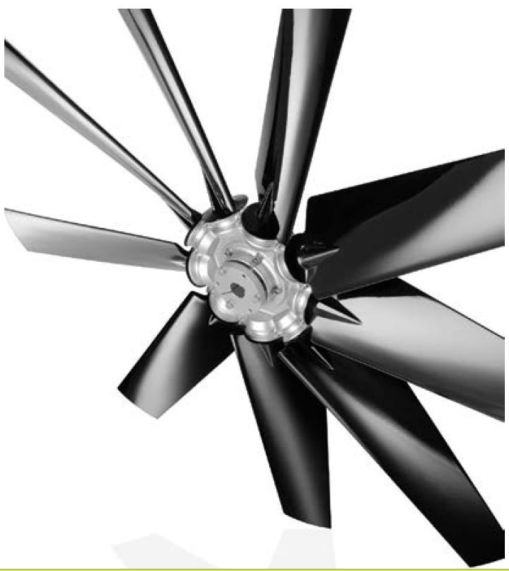
CASING BOUNDARY ISSUES – Cooling tower

"In this application, the body of the cooling tower, including inlet is made up of one piece made by fiberglass. The tower body and inlet shape is designed to optimize air distribution together with minimizing the overall cost and weight. Obviously, the "isolated" fan solution with no inlets is not the best to reach optimum fan efficiency"

BEST EFFICIENCY POINT VS ACTUAL OPERATING POINT

System efficiency can be compromised with an super efficient fan in standard sizes and models if the actual performance is off the duty point requested by the end user. This will mean a waste of energy or performance loss. In addition, with catalog fan motor combinations one is not limited to catalog fan motor combinations. For example you can spin a 762mm fan on an 11kW motor if your duty point calls for it. Again, this means avoiding an waste of energy.

Flexible axial impellers



"Flexible" means fan impellers tailored to customers' specific operating points and conditions by the option to change:

- Blade profile
- Impeller diameter - mm by mm
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- Mounting configuration

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"System efficiency efficiency may be optimized though an iterative process with axial impellers that covers:

1. Selecting different axial impeller prototypes
2. Adjusting integrated axial impellers
3. Testing & comparing the performance on the final functionality

BEST EFFICIENCY POINT VS ACTUAL OPERATING POINT

Let's make a practical example…

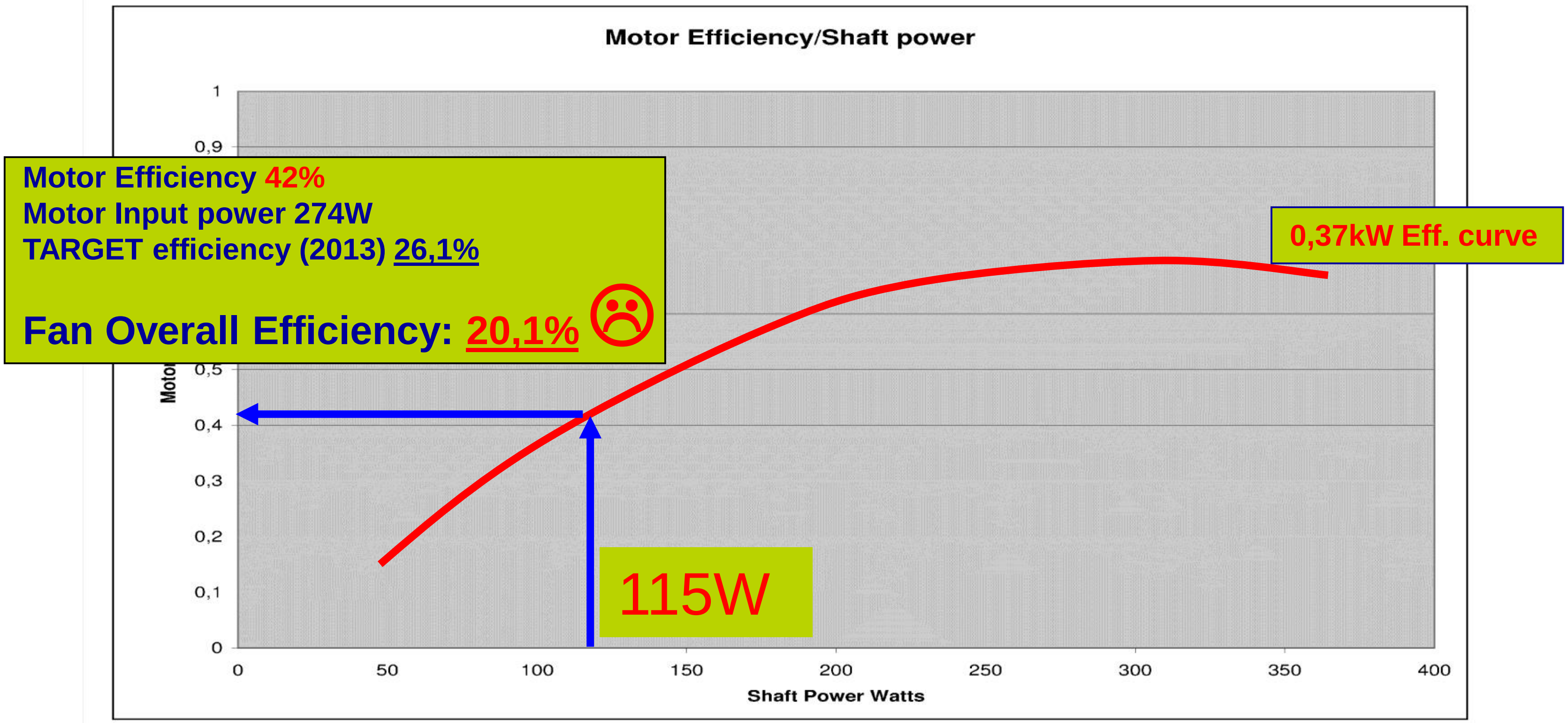
SITUATION as for std.:

Fan Impeller model ABCD @ RPM970 selected based upon the requested duty point

Absorbed shaft power at BEP= 115W

Customer's installed motor 0,37kW
SHAFT LOAD VERY LOW….

BEST EFFICIENCY POINT VS ACTUAL OPERATING POINT



BEST EFFICIENCY POINT VS ACTUAL OPERATING POINT

APPROACH 1

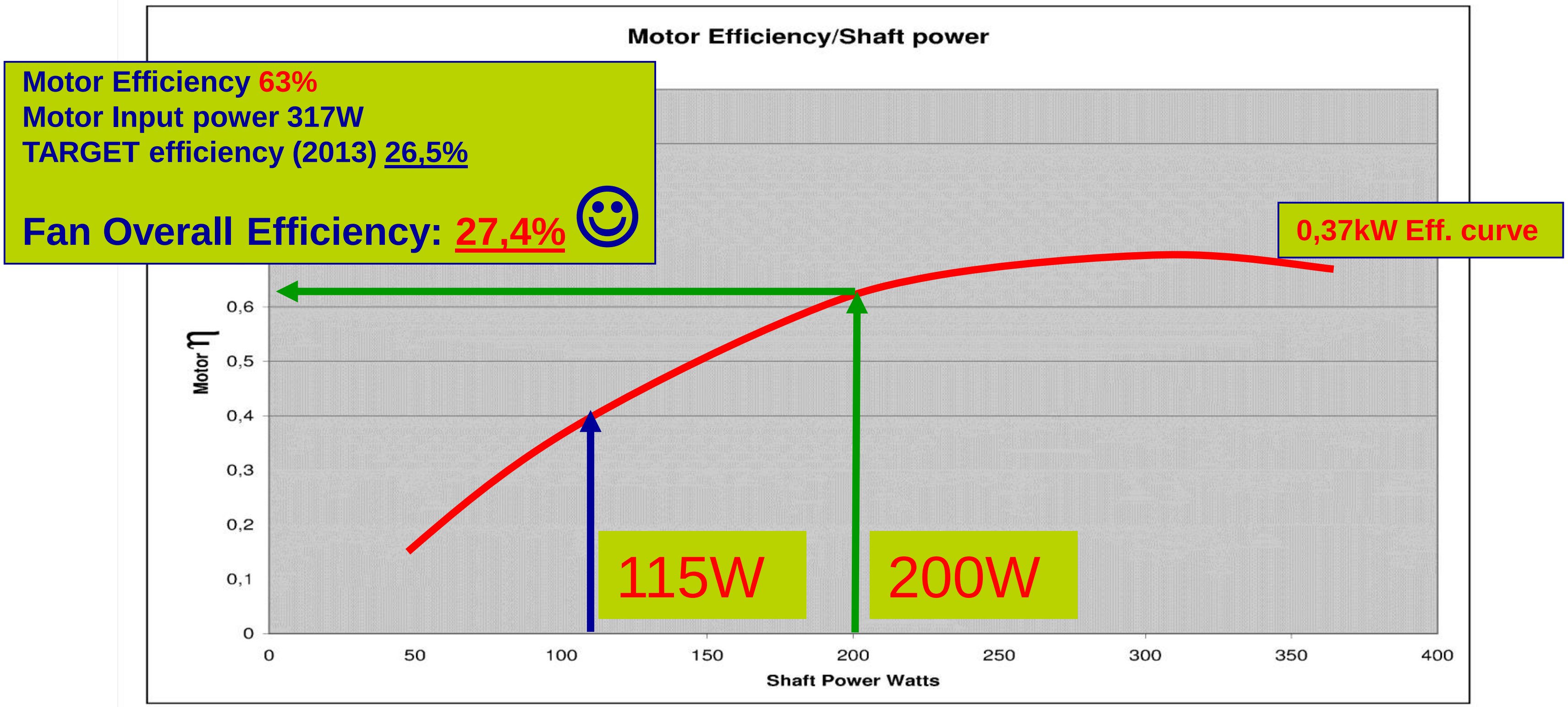
When the motor is fix as power it could be exploited the available power by an over-performing fan impeller, that's to increase the shaft charge moving to a better efficiency area.

Example:

Switching to impeller model "EFGH"

Absorbed shaft power at BEP= 200W

BEST EFFICIENCY POINT VS ACTUAL OPERATING POINT



BEST EFFICIENCY POINT VS ACTUAL OPERATING POINT

APPROACH 2

When the motor is NOT fix as power it make sense to switch to a lower motor's power maintaining the same fan impeller.

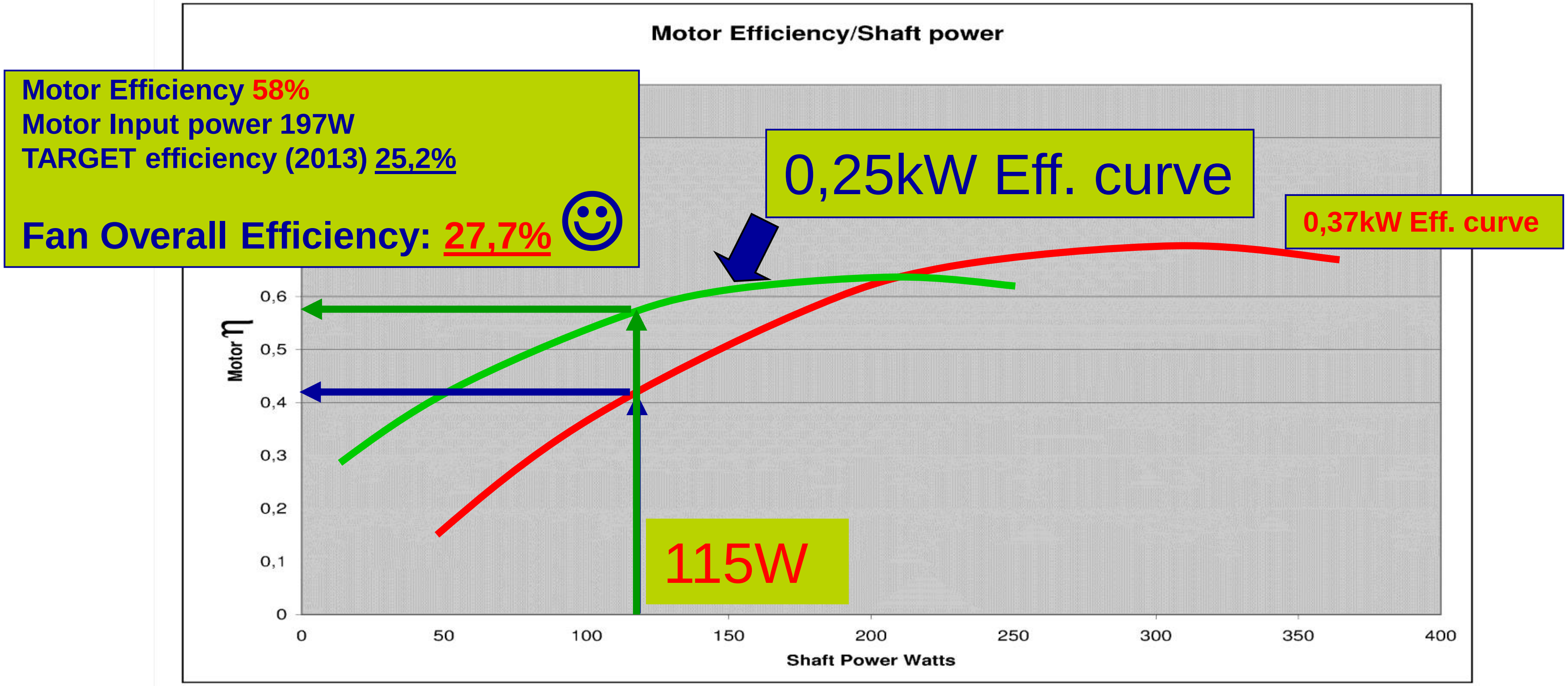
Example:

Moving to installed Motor's power 0,25kW instead of 0,37kW

Impeller model ABCD @ RPM970 (original)

Absorbed shaft power at BEP= 115W

BEST EFFICIENCY POINT VS ACTUAL OPERATING POINT



BEST EFFICIENCY POINT VS ACTUAL OPERATING POINT

Important learnings from this example

Best solution under overall efficiency point of view is to balance the fan impellers absorbed power and motor power to a point as close as possible to the shaft load connected with the motors highest efficiency. It was illustrated that when the fixing point is an best efficiency point and not the actual operating point this may be achieved by both:

A waste of energy through balancing an over-performing fan impeller with an fixed motor where the shaft load was low.

Saving energy though balancing an fan operating at the requested duty point with an motor with lower power.

This means that compliance may also be achieved by A performance loss through balancing an under-performing fan impeller with an motor with lower power (Not illustrated)

BEST EFFICIENCY POINT VS ACTUAL OPERATING POINT

Case description:

Producer of fan for live stock ventilation. Key characteristics is HIGH FLOW RATES.

Those fans for live stock must comply **ErP** when supplied on **EU** market

BEST EFFICIENCY POINT VS ACTUAL OPERATING POINT

Overall efficiency equation:

$$\eta_e = (P_{u(s)} / P_{ed}) \cdot C_c$$

(a) where the fan has been measured according to measurement category A, fan static gas power P_{us} is used from the equation $P_{us} = q \cdot p_{sf} \cdot k_{ps}$;

BEST EFFICIENCY POINT VS ACTUAL OPERATING POINT

LEARNING CONCLUSION

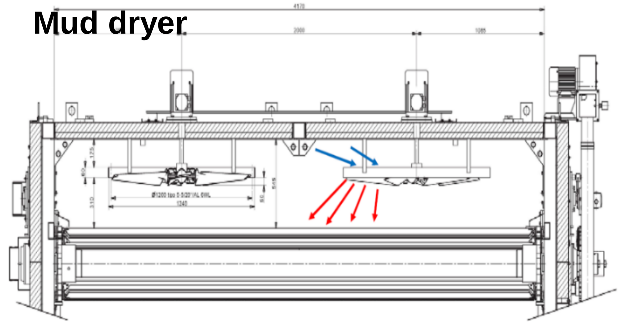
Pigs/cows wants flow and no pressure. Hence, whats good for the cows/pigs may not be the same as what is good for complying with ErP!

In addition, an fan with an lower BEF may have an higher efficiency at the operating point compared to an fan with higher BEF!

BEST EFFICIENCY POINT VS ACTUAL OPERATING POINT

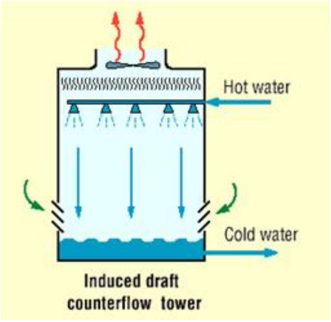
Wood drying

Mud dryer



Industrial Ventilation

Cooling tower



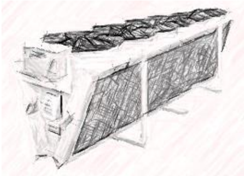
Snow Canon

Chiller

Chick Master Incubator

Live Stock Ventilation

V-Cooler…



E-Motor Cooling Package

BEST EFFICIENCY POINT VS ACTUAL OPERATING POINT

EPEE members experience is that partial optimization does not always result in total optimization of a product. The fan is one of the key components of an air conditioner, air source heat pump, etcetera which transfers heat from or to air. However, fan power has a fairly small impact on such products, but the air flow volume has a significant effect.

BEST EFFICIENCY POINT VS ACTUAL OPERATING POINT

U.S. DEPARTMENT OF ENERGY

The American Department of Energy (DOE) intends to regulate commercial fan efficiency and is considering an PEBR application dependent fan performance metric

OPTIONS TO ADDRESS ISSUES

A) EXEMPTIONS
B) “NON-FINAL ASSEMBLY” LAB CALC WITH MOTOR DATA
C) PEBR APPLICATION DEPENDENT METRICS COMBINED
WITH ““WIRE TO AIR””

CALCULATION METHOD FOR FANS SUPPLIED AS NON FINAL ASSEMBLY

327/2011 ANNEX II 3.2

$$\eta_e = \eta_r \cdot \eta_m \cdot \eta_T \cdot C_m \cdot C_c$$

ISO 12759 ANNEX B

$$\eta_e = \eta_r \times \eta_m \times \eta_T \times \boxed{\eta_c} \times C_m \times C_c$$

327/2011 does not cover the variable speed drive efficiency as ISO 12759

CALCULATION METHOD FOR FAN SUPPLIED AS NON FINAL ASSEMBLY

327/2011 ANNEX II 3.2

$$\eta_e = \eta_r \cdot \eta_m \cdot \eta_T \cdot C_m \cdot C_c$$

η_r is the fan impeller efficiency according to $P_{u(s)} / P_a$

The equation for impeller efficiency is incorrect and different from ISO 5801 in both 327/211 and ISO 12759 Annex B.

ISO 12759 ANNEX B

$$\eta_e = \eta_r \times \eta_m \times \eta_T \times \eta_c \times C_m \times C_c$$

is the optimal fan impeller efficiency according to $P_{u(s)} / P_a$, as given in ISO 5801;

ISO 5801

3.48

fan impeller efficiency

η_r

fan air power divided by the impeller power

$$\eta_r = \frac{P_u}{P_r}$$

CALCULATION METHOD FOR FAN SUPPLIED AS NON FINAL ASSEMBLY

327/2011 ANNEX II 3.2

$$\eta_e = \eta_r \cdot \eta_m \cdot \eta_T \cdot C_m \cdot C_c$$

η_m is the nominal rated motor efficiency in accordance with Regulation (EC) No 640/2009 whenever applicable. If the motor is not covered by Regulation (EC) No 640/2009 or in case no motor is supplied a default η_m is calculated for the motor using the following values:

— if the recommended electric input power 'Pe' is ≥ 0,75 kW,

$\eta_m = 0{,}000278*(x^3) - 0{,}019247*(x^2) + 0{,}104395*x + 0{,}809761$,

where $x = Lg\ (P_e)$,

and P_e is as defined in 3.1(a),

— if the recommended motor input power 'Pe' is < 0,75 kW,

$\eta_m = 0{,}1462*\ln P_e + 0{,}8381$,

ISO 12759 ANNEX B

$$\eta_e = \eta_r \times \eta_m \times \eta_T \times \eta_c \times C_m \times C_c$$

The estimated efficiency for three-phase motors shall be the minimum specified by valid legal regulations or if not in existence, the minimum specified for class IE1 in accordance with IEC 60034-30.

The estimated efficiency for all other induction motors, rated below 0,75 kW, shall be calculated using Equation (B.2):

$$\eta_m = 0{,}146\,2 \times \ln P_N + 0{,}838\,1 \qquad \text{(B.2)}$$

where P_N is the nominal motor power, in kilowatts.

327/2011 is based on input power and and ISO 12759 is based upon output power. The difference is reflected by the motor efficiency. In practice it may mean that the calculated motor efficiency based on ISO 12759 will be lower than if calculated based upon 327/2011.

CALCULATION METHOD FOR FAN SUPPLIED AS NON FINAL ASSEMBLY

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327/2011 is based on input power and and ISO 12759 is based upon output power. The difference is reflected by the motor efficiency. In practice it means that the calculated motor efficiency based on ISO 12759 will be lower than if calculated based upon 327/2011. That again means it will be harder to reach the target efficiency compared to earlier if Pe is changed to Pa in 327/2011. However, Pe may easily be calculated. This is for example illustrated in draft AMCA 207

CALCULATION METHOD FOR FAN SUPPLIED AS NON FINAL ASSEMBLY

327/2011 ANNEX II 3.2

$$\eta_e = \eta_r \cdot \boxed{\eta_m} \cdot \eta_T \cdot C_m \cdot C_c$$

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$$\eta_e = \eta_r \times \boxed{\eta_m} \times \eta_T \times \eta_c \times C_m \times C_c$$

To reach ErP compliance based on caluclation with motor defailt values requires 58%! In static efficiency when based upon the default motor effiiency linked to Pe 0.15kW vs. 48% in static efficiency when based upon the default motor efficiency linked to Pe 20.06kW. That means that impeller requirements are significant larger and unrealistic for small impellers!

Pe kW	STATIC Efficiency of IMPELLER (Q*Ps/*Abs. Mech. power*)	Efficiency of FAN (Std A)-2013	Efficiency Target ErP 2013	Efficiency of FAN (Std A)-2015	Efficiency Target ErP 2015
0.15	0.58	**0.29**	0.24	**0.287**	0.284
20.06	0.48	**0.41**	0.36	**0.414**	0.405

CALCULATION METHOD FOR FAN SUPPLIED AS NON FINAL ASSEMBLY

327/2011 ANNEX II 3.2

$$\eta_e = \eta_r \cdot \eta_m \cdot \eta_T \cdot C_m \cdot C_c$$

— for direct drive $\eta_T = 1{,}0$;

— if the transmission is a low-efficiency drive as defined in 1(9) and

— $P_a \geq 5$ kW, $\eta_T = 0{,}96$, or

— 1 kW < P_a < 5 kW, $\eta_T = 0{,}0175 * Pa + 0{,}8725$, or

— $P_a \leq 1$ kW, $\eta_T = 0{,}89$,

— if the transmission is a high-efficiency drive as defined in 1(10) and

— $P_a \geq 5$ kW, $\eta_T = 0{,}98$,

— or 1 kW < P_a < 5 kW, $\eta_T = 0{,}01 * Pa + 0{,}93$, or

— $P_a \leq 1$ kW, $\eta_T = 0{,}94$.

Pa vs. Pn. However, impact insignificant…

ISO 12759 ANNEX B

$$\eta_e = \eta_r \times \eta_m \times \eta_T \times \eta_c \times C_m \times C_c$$

Table B.1 — Default values for belt drive efficiency

Nominal motor power	η_T (V-belts)	η_T (flat belts)
P_N < 1 kW	0,89	0,94
1 kW < P_N < 5 kW	$0{,}017\,5 \times P_N + 0{,}872\,5$	$0{,}01 \times P_N + 0{,}93$
P_N > 5 kW	0,96	0,98

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$$\eta_e = \eta_r \times \eta_m \times \boxed{\eta_T} \times \eta_c \times C_m \times C_c$$

D.2.2 Impeller power is the mechanical power supplied to the fan impeller in a cased fan. This is denoted as P_r, and is expressed in watts or kilowatts. P_u is the fan air power and fan impeller efficiency is:

$$\eta_r = \frac{P_u}{P_r} \qquad (D.1)$$

expressed as a decimal.

This is directly applicable to fan arrangements 4, 5, 15 and 16 (see ISO 13349).

D.2.3 Fan shaft power is the mechanical power supplied to the fan shaft. This is denoted as P_a, and is expressed in watts or kilowatts. P_u is the fan air power and fan shaft efficiency is:

$$\eta_a = \frac{P_u}{P_a} \qquad (D.2)$$

expressed as a decimal.

This is directly applicable to all other fan arrangements, i.e. 1 to 3, 6 to 14 and 17 to 19 (see ISO 13349).

It differs from the impeller power by the addition of power losses in the fan bearings as a result of friction.

Hence, Pr=PA for direct drive..

CALCULATION METHOD FOR FAN SUPPLIED AS NON FINAL ASSEMBLY

327/2011 ANNEX II 3.2

$$\eta_e = \eta_r \cdot \eta_m \cdot \boxed{\eta_T} \cdot C_m \cdot C_c$$

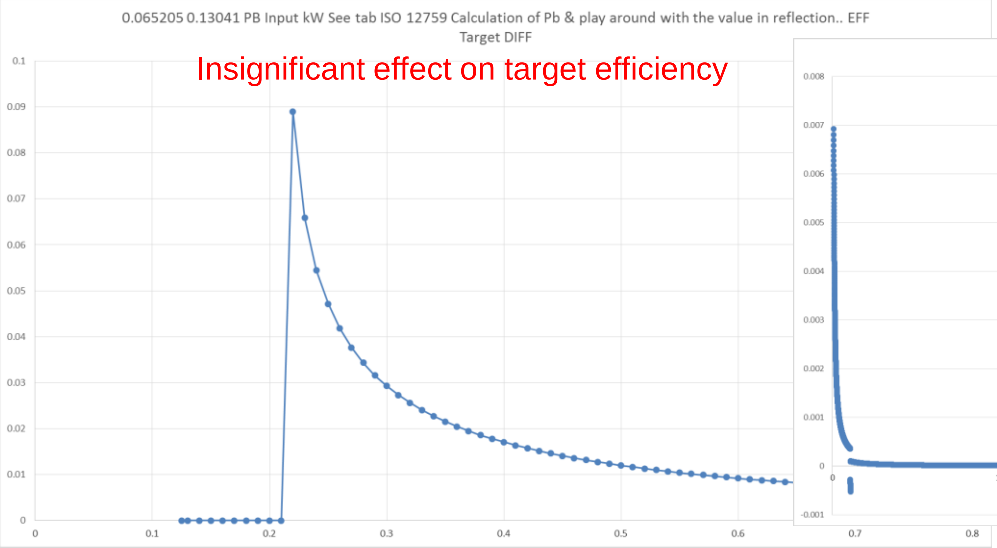
ISO 12759 ANNEX B

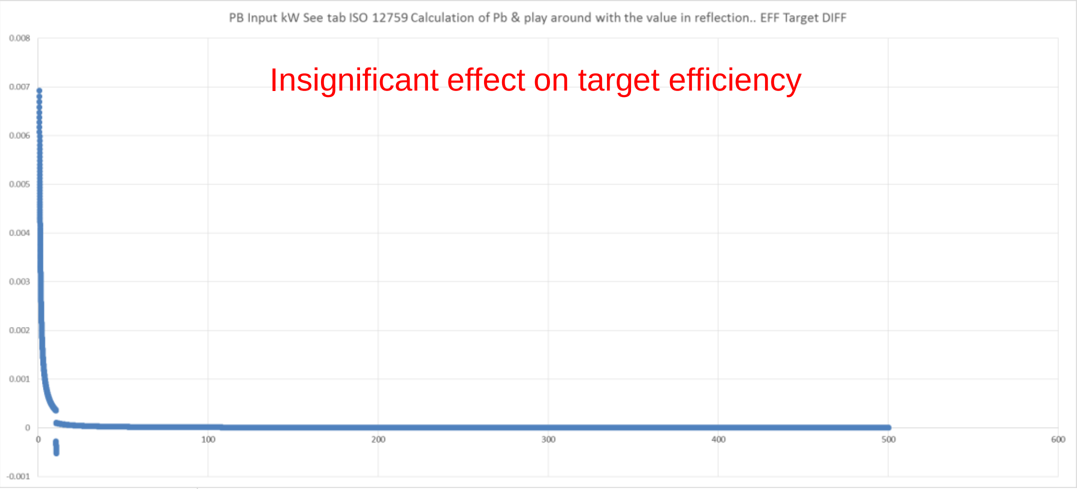
$$\eta_e = \eta_r \times \eta_m \times \boxed{\eta_T} \times \eta_c \times C_m \times C_c$$

D.2.4 Bearing frictional power: these losses can be obtained from Equation (D.3):

$$P_b = 1{,}05 \times 10^{-4} \times M \times N \qquad \text{(D.3)}$$

Assuming Deep groove ball bearings Single row d 150mm fit for an motor shaft size related to 500kW big motor.. Assuming highest possible values





CALCULATION METHOD FOR FAN SUPPLIED AS NON FINAL ASSEMBLY

327/2011 ANNEX II 3.2

$$\eta_e = \eta_r \cdot \eta_m \cdot \boxed{\eta_T} \cdot C_m \cdot C_c$$

ISO 12759 ANNEX B

$$\eta_e = \eta_r \times \eta_m \times \boxed{\eta_T} \times \eta_c \times C_m \times C_c$$

Assuming Deep groove ball bearings Single row d 150mm fit for an motor shaft size related to 500kW motor.. Assuming highest possible values for that type of ball bearing….

Insignificant effect on motor shaft charge

absorbed Power impeller at BEP ***Absorbed*** **[watt]**	Motor shaft charge
19200	1.081
19330	1.088

Insignificant effect on motor shaft charge

absorbed Power impeller at BEP ***Absorbed*** **[watt]**	Motor shaft charge
2600	0.944
2730	0.989

Significant effect assuming the mm size of an huge ball bearing…

absorbed Power impeller at BEP ***Absorbed*** **[watt]**	Motor shaft charge
500	0.67
630	0.84

Obviously, its not exhaustive. However, it gives an indication of the importance…

CALCULATION METHOD FOR FAN SUPPLIED AS NON FINAL ASSEMBLY

327/2011 ANNEX II 3.2

$$\eta_e = \eta_r \cdot \eta_m \cdot \eta_T \cdot \boxed{C_m} \cdot C_c$$

C_m is the compensation factor to account for matching of components = 0,9;

C_c is the part load compensation factor;

ISO 12759 ANNEX B

$$\eta_e = \eta_r \times \eta_m \times \eta_T \times \eta_c \times \boxed{C_m} \times C_c$$

ANNEX B B1.

C_m is the compensation factor to account for matching of components = 0,9;

No definition of the compensation factor to account for mathing of components. What is an example of an good mathing? What is an example of an bad matching that will =.9?

CALCULATION METHOD FOR FAN SUPPLIED AS NON FINAL ASSEMBLY

327/2011 ANNEX II 3.2

$$\eta_e = \eta_r \cdot \eta_m \cdot \eta_T \cdot \boxed{C_m} \cdot C_c$$

ISO 12759 ANNEX B

$$\eta_e = \eta_r \times \eta_m \times \eta_T \times \eta_c \times \boxed{C_m} \times C_c$$

ANNEX B B1.

C_m is the compensation factor to account for matching of components = 0,9;

However, the compensation factor may be derived from ISO 12759 Annext B B

ISO 12759 ANNEX B B1.

To encourage the improvement of the efficiency of the components offered as a complement to bare shaft fans, actual efficiency values provided by component manufacturers shall preferably be used instead of default values.

D.2.5 Motor power

Perhaps the most common type of motor used in fan installations (certainly above an output of 1 kW) is the squirrel cage a.c. induction design. It is robust, reliable, requires minimum maintenance and is relatively inexpensive. There has been a gradual improvement in its efficiency at both full and partial loads. This has been achieved by the inclusion of greater amounts of active material. Three efficiency levels are standardized in IEC 60034-30. The efficiency for actual motors at partial loads (around 75 % of nameplate rating) can sometimes be greater than that at full load. This is contrary to earlier designs. It is important to use the efficiency at the actual absorbed power, which may be calculated using any of the methods described in IEC 60034-2-1.

D.3 Mains power required

The electrical power input abstracted from the mains may be calculated using Equation (D.9):

$$P_e = \frac{q_{vsg1} \times p_f}{\eta_r \times \eta_b \times \eta_T \times \eta_m \times \eta_c}$$

where

P_e is the electrical input power, in kilowatts, alternatively in watts;

q_{vsg1} is the flow rate, in cubic metres per second or litres per second (m^3/s or l/s);

p_f is the fan pressure, in kilopascals or Pascals;

η_r is the fan impeller efficiency, expressed as a decimal;

η_b is the fan bearing efficiency, expressed as a decimal;

η_T is the transmission efficiency, expressed as a decimal;

η_m is the motor efficiency, expressed as a decimal;

η_c is the control efficiency, expressed as a decimal.

Based on this it may be infered that Cm may be expressed as associated with specific load including any influence from VSD and presence of bearings. However, it is not expressed in an definition.. That would be helpful..

CALCULATION METHOD FOR FAN SUPPLIED AS NON FINAL ASSEMBLY

327/2011 ANNEX II 3.2

$$\eta_e = \eta_r \cdot \eta_m \cdot \eta_T \cdot C_m \cdot \boxed{C_c}$$

ISO 12759 ANNEX B

$$\eta_e = \eta_r \times \eta_m \times \eta_T \times \eta_c \times C_m \times \boxed{C_c}$$