WELCOME TO
Motor Systems Tool Webinar
October 15, 2015
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Agenda

- Introducing The MST-Tool
  - Thoughts behind, background story etc.

- Demonstration of some of the possibilities in MST-Tool
  - Calculation examples brought by the trainer.
  - *Approach from net, from application, Energy calculations - before/after scenarios*

- Demonstration of some of the algorithms inside the tool
  - Motor model, gear model…

- “Live session” – demonstrating calc example by screen sharing

- Q&A, End of webinar
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October 15, 2015 – Online, Internet

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– Danish Technological Institute

- Electrical Engineer (1996) - Drives specialist, programmer

- Employments:
  1996-2001 – ABB (Drives specialist)
  2001-2002 – DEFU (Multiple Energy Projects)
  2002- present:
    Danish Technological Institute
    • Multiple Energy Projects
    • Technical consultant for Danish Energy Agency (ECO-design motors, pumps)
    • External Trainer at Grundfos A/S (pumps and pump applications)
    • DAQ software development
    • Head of accredited testing laboratories motors & circulators
    • Task leader in EMSA since 2009
    • IEC TC22G WG18 member – Drives efficiency (Internationalization of EN 50598 series)
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Background

- Long Danish tradition of looking at motor systems
  - Decades of analysing motor systems, focus on systems!

- Culmination of several publically financed projects since late 90's
  - A *programmed version of multiple findings*...

- Key words of the Tool:
  - Easy to use, easy accessible, no need for pre-knowledge, Impartiality!

- Target group for the Tool:
  - Engineers, Machine builders, Energy advisers, Trainers, etc.
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Basic build up:

Define key components:
- Load
- Transmission
- Motor (Drive)

Put in one known dutypoint:
- kW and speed on load, on shaft or from wall outlet?

Main screen window:
- Dynamic calculations
  - Auto or manual
  - Direct result!

- Speed change analysis

- Drive analysis

- Economy analysis

Snapshot window

Energy window:
- Energy calculations
- Drive comparison
- Duration curves etc.
The first group (1) consists of machines for winding material under tension. This group includes, for example, veneer cutting machines and machine tools.

Group (2) consists of conveyor belts, cranes, positive displacement pumps as well as machine tools.

Group (3) consists of machines such as rollers, smoothing machines and other processing machines.

Group (4) comprises machines operating by centrifugal force, such as centrifuges, centrifugal pumps and fans.
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Demonstrating the tool

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Demonstrating the tool

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\[ P_{\text{hyd}} = Q \left( \frac{m^3}{s} \right) \cdot \Delta p \ [Pa] \]
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- Algorithms inside the tool – Motor model:
  - Classic eta shape of motor:

Input parameters:
- Nominal:
  - Output power
  - Efficiency
- Actual:
  - Power (in- or output)

- Alpha constant
- Nominal eta and motor size (kW)

Source:
Study from DTU – Technical University of Denmark
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- Algorithms inside the tool – Motor & Converter:

- Input parameters:
  - Nominal:
    - Output power
    - Efficiency
  - Actual:
    - Speed
    - Torque
    - Control mode

- Source:
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Model for PM, motors and drives:
- Motors D.O.L. (selected sizes)
- Motors with VSD (std. flux)
- Motors with VSD (AEO)
- PM Motors 1500 rpm nominal
- PM Motors 1800 rpm nominal
- PM Motors 3000 rpm nominal
- PM Motors 4500 rpm nominal

- Same formula – different constants:

\[ P_{tab} = 0.375 \cdot (P_{ind,nom} - P_{mek,nom}) + 0.221 \cdot (P_{ind,nom} - P_{mek,nom})^2 - 0.052 \cdot (\frac{n}{n_{nom}})^2 \cdot (P_{ind,nom} - P_{mek,nom}) - 0.224 \cdot (\frac{n}{n_{nom}})^2 \cdot (P_{ind,nom} - P_{mek,nom})^2 + 0.633 \cdot (\frac{M}{M_{nom}})^2 \cdot (P_{ind,nom} - P_{mek,nom}) + 0.05 \cdot (\frac{M}{M_{nom}})^2 \cdot (P_{ind,nom} - P_{mek,nom})^2 - 0.02 \cdot (P_{ind,nom} - P_{mek,nom}) \cdot (\frac{n}{n_{nom}})^2 \cdot (\frac{M}{M_{nom}})^2 \]
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- Demonstration of some of the algorithms inside the tool – Gear I:

  Worm gear

  Bevel gear

  Helical gear

- Source: DK Study: “Systems optimization part I”
Demonstration of some of the algorithms inside the tool – Gear II:

\[ \eta = \alpha \cdot \left( \frac{\text{Load}_{\text{actual}}}{\text{Load}_{\text{nom}}} \right) + \beta \cdot \left( \frac{\text{Speed}_{\text{actual}}}{\text{Speed}_{\text{nom}}} \right) + \eta_{\text{nom}} + \text{Const} \]
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- Demonstration of some of the algorithms inside the tool – Belts:
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- Demonstration of algorithms inside the tool – General methodology:

  - P2 -> P1
    Known formula

  - P1 -> P2
    “Search” P1 from table (0 – 130% load)
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P4 Application input – evolved 1:

- Fan – Known Parameters
- Pump – Known Parameters
- Other duty

Efficiency suggestions (Danish)
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P4 Application input – evolved 2:

- Full load profile implemented
- 12 duty points needed by definition

\[ P_{\text{hyd}} = Q \left[ \frac{m^3}{s} \right] \cdot \Delta p \ [Pa] \]

Calculated from two inputs
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Before/After comparison:
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- Time for live demonstration…

*Example 2 from web page*
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Future plans:

- Translation to more languages
- Slip calculation on standard motors D.O.L.
- New technologies (Co-operation with University of Gent, Belgium)
- Better application calculator (compressors)
- Better energy calculator (print, save, report etc.)
- Incorporation of legislation values for components (EU, US etc.)
- IEC TC22G WG18 output implemented in MST-Tool
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