INTELLIGENT VALVING

Hydraulics & Pneumatics – Advantages

- Proportional control
- On-Board diagnostics
- "Health Monitoring"
- Less Wiring – CAN-BUS
- Safety
- Expandability
- Self Adjustment independent of main computer
- Higher Performance
- Parameters are stored at valve
- Higher accuracy (position control, etc.)
- Repeatability

Hydraulics and Pneumatics – Disadvantages

- Cost
- Duplication of some components
- Temperature
- Vibrations
- Shock
- Requires High IP rating (67 or better)
- Some applications require explosion proof
- Special software
- Higher electrical energy consumption, but minimal
- Energy consumption to produce the control (chips, etc.)

CAN SO-CALLED ENERGY EFFICIENT FLUIDS REALLY REDUCE ENERGY LOSSES IN HYDRAULIC SYSTEMS?

- Is there any research on energy efficient fluids?
- What is holding the market for energy efficient fluids?
    - It is a balance of costs and benefit.
- Can we demonstrate the energy efficiency?
    - Too much variability in operating conditions.
- Commercially available high performance Hyd-fluid vs. standard Hyd fluid about 6Y – in the industrial application.
- Bio-degradability?

For Energy Efficiency

- Users need to see a benefit in their application and operations
    - Most of the end users need to show the results – the benefits
- Getting government funding is a challenge – interesting to see academic development
- Commercialization is a struggle,
- Need to understand the drivers for energy efficiency improvement in hydraulic systems – fluids.
    - There are several hydraulic fluids out there with higher efficiency – but at higher cost.
- Biodegradability – expensive. That is the end user value?
    - Need to be same or low cost at the same performance levels.
- Energy efficiency fluids –
    - Focus is on pump
    - What about the on the overall system?
- If fluids should be considered as part of the equipment, instead of after design
- Need to get to the level of acceptance if fluids are part of the design phase.

Key Question:

Is there a demand?
Who drives – organization like what we have today NFPA/CCEFP?
If there is no pull for energy efficiency forward, it is going to be a hard sell.
Comparison of how in auto industries work together on the CAFÉ with components manufacturers – what will take to do the same with hydraulics industry?

Takeaway

1. Commercial fluids are available
2. OEM/component manufacturers
3. Need to identify/better understand the market drivers
4. Need to integrate fluid as part of equipment design
5. Standardization on how energy efficiency improvement in equipment and machines needs to be achieved.

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1. Disconnect between capital equipment buyer at user and designer at OEM.
2. Pressure control in plant
3. Lead Remediation – how to encourage?
4. Equating energy costs with product costs – don't currently measure.
5. Sustainability
6. Cost of Ownership
7. Sizing correctly at design process – pressure – flow - speed

WHERE ARE YOU WASTING ENERGY IN YOUR HYDRAULICALLY POWERED MOBIL EQUIPMENT?

- Continuous running PTO's – pumps and fixed displacement systems.
- Lawn care equipment
    - Hydrostatics provide quick response but manufacturer has to add bleed orifices to control this, which builds inefficiencies.
        - Need to balance user experience and vehicle responsiveness – such as pressure rise-rate valve
- In Lift and Lower Circuits
    - Recover energy in lowering function – such as regeneration
- In Hybrid Vehicles
    - Use a smaller engine to accelerate especially with Tier 4
- Suggested operating hydraulically in mobile hydraulics
    - Generators
    - Fan drives
    - Air conditioning – variable speed
- Suggested proper component selection to balance system pressures
    - Control pressure drops through valves and circuits – high psi drops and leakage rates in valves
    - Proper hose sizes
    - Proper inlet and return flow and back pressure, evaluate plumbing efficiency
- Suggested a mandate of non-NPT fittings
    - Generate heat
    - Add to system contamination
    - Limit system pressures below 3000K
- Smart charge pump
    - Load sense charge pressure
- Proper fluid usage – synthetic fluids
    - Viscosity – less temperature sensitive
    - Quieter
    - Need to implement industry standards to compare fluids
    - Heat considerations – keeping the oil cooler
- Suggested a free piston engine pump
    - Is an engine and pump in one unit, no crank shaft
    - Is compact
    - Variable displacement – efficient
    - Is instant on/off – no idle
    - Individual per work circuit
    - Uses two combustion pistons
        - Cleaner
        - More efficient
        - Modular

- Suggested inline accumulators
    - Anntinuator (silencer)
- Elastimer accumulators – non-nitrogen
- Suggested pump controls rather than valve controls
    - Control energy used vs. energy pumped
- Electric (remote controls) vs. hydraulic controls
- Leverage success with DOD to DOE
    - Mining/Defense – vulnerability of workers
- Invest in smaller components to improve efficiencies such as variable displacement axial piston pump
- Revisit older technologies designed for past inefficiencies which were not valuated in the past
    - Example – snow blower using a fan belt clutch pump, plus PTO/motor which was able to reduce fuel consumption in half
- Manufacturers to improve pump internals to present cavitation
- Manufacturers to tighten manufacturing tolerances and finishes to improve efficiencies, possibly through break-in of product

RESEARCH NEEDS OF FLUID POWER INDUSTRY

- Need more pneumatic research
- Systems focused research and tools
- Application-specific knowledge needed, especially at component and system manufacturers
- Test bed demonstrations are important
- Alternative materials for fluid power component to lower weight and cost
- Net or near net manufacturing technologies
- Manufacturing methods or design alternatives that move fluid power manufacturing from a batch process to a more continuous flow process
- Hydraulic fluid research must keep pace with component and system advances (compatibility, optimization)
- Next generation fluids and additives
- Surface texturing
- Standardized test methodologies that approximate/emulate real world use of equipment and components
- Energy recovery

Observations/Softer stuff

- Need more interaction between OEM, end user, government, suppliers, industry organizations
- Industry needs to learn the potential benefits of leveraging government funding to accomplish their goal
- Education and outreach
    - Increase exposure to fluid power to students at K-12
    - Increase fluid power course offerings at undergraduate and graduate levels
    - Increase public knowledge of fluid power; it should be less of a “black box”
    - Partner with organizations like SAE to add fluid power to existing programs (e.g., mini-baja)
    - Increase programs such as Lego robotics and First robotics

CALL TO ACTION – HOW DO WE GET BEYOND THE TALKING STAGE?

- Energy Efficiency taps on all hydraulic cylinders – not unlike Energy Star Program
- Request government backing – financial support for more research
- More fluid power education – most universities have limited educational opportunity
- Standardization is needed – to compare apples to apples
- Customer awareness – publicize energy usage for components used – to help in decision process
- Government subsidy or other reward reduced energy costs, etc. for clearly documented energy savings from year to year – motivation
- More forums like this Energy Efficiency Conference
- More regulation and legislation to help set goals for energy efficiency

Potential Barriers:

- Time suck on people/resources – making time
- Stronger voice on Capitol Hill – Lobbyists – for more resources
- Educate the general population on potential savings

ENERGY SAVINGS/HYDRAULIC COMPONENT TECHNOLOGIES

What is the root cause of hydraulic inefficiencies?

Reservoir Design – can it be built to improve hydraulic efficiencies?

Aeration – leads to inefficiencies and component damage

Fluid needs to be "improved" while in reservoir

How do you measure efficiency? And, do people actually do?

Is America lacking or falling behind in fluid power education and design, compared to other countries?

USA energy costs contribute to lack of ingenuity

System inefficiencies are built in with each component that is used

Example: Accumulator with F/C – built-in inefficiency

Example: All the hose and tubing/fittings

HOW TO ENCOURAGE EVALUATING PURCAHSING PNEUMATIC MACHINERY ON COST OF OWNERSHIP RATHER THAN PURCHASE PRICE?

- Many customers are asking about energy – especially the more sophisticated (more on a personal level than organizational)
    - Varies by industry
- "What more does it cost me?"
- Customers who shop on price
    - Face time with application person; education
    - Often dealing with a buyer and need to get beyond them
- Public vs. Private Companies
    - More cost of ownership opportunity (or less resistance) when dealing with private companies
- ROI Discussion
    - Don't talk about payback for simple stuff
    - Lack of understanding at end user level can make ROI discussion challenging
    - Component OEMs have the tools and are educated; more may be needed at integrator level
    - 6-12 months is common with consulting (won't touch something with 2-year timetable)
    - Direct implication on fiscal planning and ROI timetable
- Information required to make decisions easier
    - Don't only look at a graph; utilize software to continually monitor
    - At Integrator or OEM level:
        - Lack of information consistency between component providers makes it challenging to an OEM to look at all the information
        - AUTOCAD is an example of an industry standard
    - Shift in how companies buy equipment
        - Buyers are only concerned with purchase price
        - People on the floor don't get the latest picture
        - Have to get to people that have a stake in long-term cost savings
        - Companies that sell on Energy Efficiency have to be the connector within the organization
- Is there a shift towards sustainability as a role?
    - Even large companies that have sustainability focus may not have this individual
    - Auto companies are starting to have this which makes it easier to have this discussion
- Energy Efficiency
    - Hydraulics – "there is a puddle on the floor"
    - Pneumatics – only air
        - This is a key challenge to overcome
- How do you bring people together?

- Education and expertise from a vendor can help close the gap
- Role of technology teams
    - Even though they may have made the decision to go with the higher startup cost but longer long term cost, the buyer may not execute this decision
- How do you get specs in?
    - Energy criteria are often not part of the spec
    - Getting energy on the spec may need to be a focus of professional organizations or government agencies to help make change happen
- Role of Energy Credits
    - Local credit programs can subsidize the standard costs
    - OEMs and components suppliers can be better at exploring this and providing information down channel

Fluid Power Training (and Certification) as an Energy Saving Tool

Rance Herren, 28 November 2012

1. Energy is wasted because of a lack of knowledge.
    a. Engineering programs that do not emphasize training in their curriculum and view fluid power as just another means of mechanical power transmission. In this, they inadvertently promote the misconception that fluid power is an "easy" technology that doesn't really require additional or specific training. We all know this is not true
    b. Misidentifying system malfunctions and putting on "band-aids" that only mask the root cause and you end up paying for it twice.
    c. In the plant, the person that by blind luck has solved a hydraulic or pneumatic problem is designated as the "expert" and is turned to for solving other problems without additional or maybe any training at all.
    d. Much of the existing fluid power training in the past has been "preaching to the choir", fluid power distributors and some forward thinking OEMs.
    e. End users and even some OEMs do not really know that the need training and certification.

2. How do we get technology engineered into a system so that the system is energy efficient?

3. How do we get training for those responsible in maintaining that system can do so to maintain system energy efficiency?

4. Making the case to the management to encourage training and certification?
    a. Training seminars to change culture
    b. Case studies
    c. White papers
    d. Success stories (testimonials)
    e. Demonstrate savings though metrics of reduced machine downtime and energy savings

5. Incentive to become trained and certified.
    a. Condition of gaining and maintaining employment
    b. Salary increases
    c. Promotion

6. Other strategies:
    a. Marketing outside of the traditional fluid power community to different publications and organizations.
    b. Fluid power component manufacturers encouraging distributors to provide training to smaller OEMs and end users
    c. Pull "marketing" to end users that will demand those engineering and servicing equipment be trained and certified.

PUMP CONTROL VS. VALVE CONTROL: PROS AND CONS

PUMP CONTROL	VALVE CONTROL
Higher Efficiency (Slower Response)	High Performance (Throttling Losses)
Application Specific	
Single Axis	Multi Axis Leveraging Central Power Source
Variation of Load Operational Profile	
Given Profile Single Axis ⇩ Design for Purpose & Efficiency	Multi-Axis ⇩ Hugh Throttling Losses ⇩ Modular and Scalable
Design Focus (OPEX vs. APEX)	
Efficiency Life of System Cost	Initial Cost