Optimization of Power Shuttle Valve using MATLAB

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Overview of Presentation

• Introduction.
• Objective.
• PST valve model using Simulink-Simscape.
• Results and Summary
• Summary
Introduction

- Power shuttle transmission generally used in Tractors, consists of multi-plate (wet) clutch and an additional hydraulic unit i.e. power shuttle valve.

- The Forward/Reverse operation with Power shuttle transmission provides better comfort, controllability and improves productivity especially in Loader-Dozer application.

- The power shuttle valve is operated by a F/R lever. In forward position, the pressure is built in the forward clutch whereas in reverse position, the pressure is built in the reverse clutch.

- This pressure rise in the F/R clutch makes the vehicle to make in F/R direction. Flow to tank line is blocked during the flow to F/R clutch.
Objective

• To study the pressure modulation and effect of various parameters on pressure modulation of the Power shuttle valve.

• To optimize the pressure modulation curve for shifting jerks and delay.

• To reduce the no of trials to be done on actual vehicle for the purpose of optimization.
Power Shuttle Transmission

- **F/R Lever**
  - PST Valve
    - Reverse Clutch engaged and Forward Clutch disengaged
    - Forward Clutch engaged and Reverse Clutch disengaged

- **Inching Pedal**
  - PST Valve
    - Pedal pressed, Clutch disengaged
    - Pedal released, Clutch Engaged
PST Valve Model

• Power shuttle valve components like priority section, modulation section, inching section etc. are modelled.

• Operator input operates the F/R and inching control.

• Mathematical model for Spring and Constraints is developed in Simulink and for other components Simscape is used.

• Priority valve ensures a fairly constant flow rate from Pump to the F/R valve which also flows to modulation valve.

• F/R valve is connected to the Clutch which is engaged by the fluid pressure.

• Inching valve relieves the pressure in the clutch thereby allows inching of the vehicle.
Results

Pressure v/s Time for F/R operation.
Results

Pressure v/s Time for Inching operation.
Conclusion

• A optimized solution for this PST is obtained, which is very close to the actual requirement.

• Using this simulation for determining modulation curve, physical test needed for PST optimization reduced significantly.

• The results obtained from this kind of simulation provides not only basis for evaluation of PST valve performance but also for enhancement that can be done in the design.

• Other issues, if simulated and verified, they can be resolved at an early stage.

• Risk of introducing new concepts can be reduced with these kind of virtual validation
References

• Matlab-Simulink-Simscape users guide.
• Matlab-Simulink-Simscape Tutorials.
Thank you

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