FLOWNEX®
SIMULATION ENVIRONMENT

GI-GABRIEL AUTOMOTIVE WASHING

During the manufacturing process, tubular parts are machined and welding is performed on these parts. Before these components can be painted and assembled, they need to be cleaned to remove dirt, loose metal pieces and contaminants. The washing machines that GI-Gabriel currently employs do not remove these contaminants sufficiently. Flownex was used to simulate flow rates and pressure of water at the nozzles to ensure correct design changes were made and optimal cleaning achieved

AUTOMOTIVE INDUSTRY

CUSTOMER PROFILE:

CI-Gabriel manufactures, distributes and supplies the automotive market with ride control products (shock absorbers, struts and gas springs). It also sells directly to consumers in the aftermarket throughout Southern African. Approximately 10 000 units are manufactured daily to meet demand.

CHALLENGE:

During the manufacturing process, tubular parts are machined and welding is performed on these parts. Before these components can be painted and assembled, they need to be cleaned to remove dirt, loose metal pieces and contaminants. The washing machines that GI-Gabriel currently employ do not remove these contaminants sufficiently. Flownex was used to simulate flow rates and pressure of water at the nozzles to ensure correct design changes were made and optimal cleaning achieved.

BENEFITS:

- Tedious manual calculation of pressures and flow rates at the nozzles were avoided.
- The team could accurately determine where to place the nozzles to ensure that the flow is evenly distributed through use of the designer feature in Flownex®.
- The cyclic operation for the washing machine could be fully simulated.
- Performance characteristics of the new system could be compared to the old system in the design phase. This helped to ensure that the final design performed satisfactorily. The earlier design changes are made the more affordable the changes are.

SOLUTION:

Through use of Flownex®, the team was able to determine if the design met the required specifications, and also realised significant improvements to the previous industrial washing machine system.

"Flownex® proved to be very user friendly and support services from M-Tech Industrial were first rate. The engineering team for this project recommends Flownex® without any reservation for any pipe network problems of this nature. It is a powerful design tool and frees time which can be spent on other aspects of the design project"

Dawid Jacobus Dippenaar - Design Team Member; M. Eng, University of Stellenbosch

GABRIEL – INDUSTRIAL WASHING MACHINE

INTRODUCTION

Global Engineering Teams (GET) is an academic initiative between numerous universities and companies worldwide. In the GET program, groups of students complete projects for industrial partners as part of their academic studies. One of the industrial partners, Control Instruments (CI)-Gabriel, had an ineffective industrial washing machine that was used on the plant to clean cylindrical struts. CI-Gabriel tasked one of the groups to design an improved and optimised industrial washing machine. The washing machine design that the group proposed used pressurised water and was a mesh of pipes with spray nozzles at several points. The group needed to know the flow rates and the pressure at the nozzles to ensure that the design met with the client specifications.

The current spray system has poor coverage of the struts. Impact force from the sprayed water is also low due to poor nozzle choice.

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CHALLENGES

The group needed to:

- Simulate flow rates and pressure of water at the nozzles.
- Use Flownex® to optimise the design for efficiency and effectiveness.

BACKGROUND

CI-Gabriel manufactures, distributes and supplies the automotive market with ride control products (shock absorbers, struts and gas springs). It also sells directly to consumers in the aftermarket throughout Southern African. Approximately 10 000 units are manufactured daily to meet demand.

During the manufacturing process, tubular parts are machined and welding is performed on these parts. Before these components can be painted and assembled, they need to be cleaned to remove dirt, loose metal pieces and contaminants. Any contaminants left on the parts may lead to rejected components after the assembly process. This may result in possible loss of income and waste of raw materials.

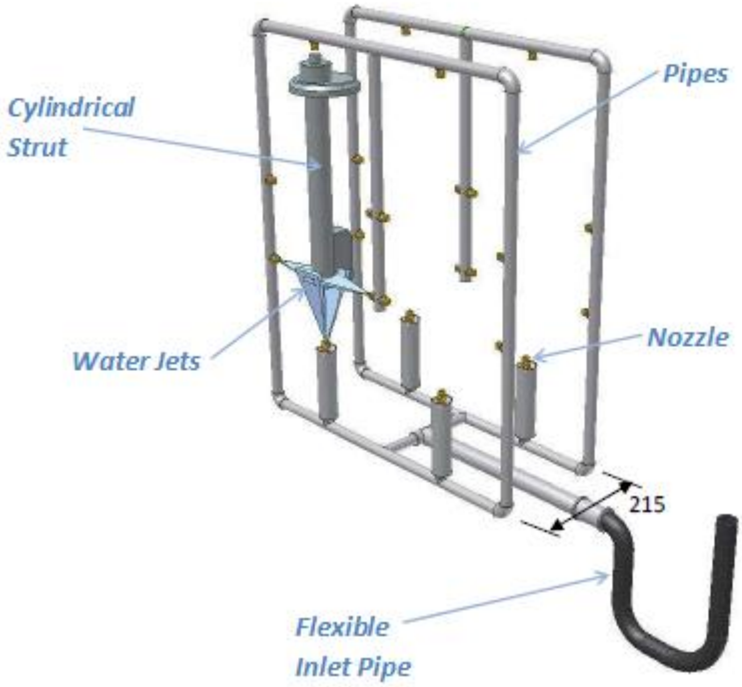

Figure 1: The pipe network of the new washing machine.

The washing machines that GI-Gabriel currently employ, do not remove these contaminants sufficiently. The amount of water consumption and use of chemicals are other concerns with the current machines. CI-Gabriel challenged one of the GET groups to design a new inline automated washing machine.

The pressurised water enters the pipe networks at the flexible inlet pipe from a high pressure pump. One strut is shown going through the machine and the light blue triangles represent water jets flushing away dirt from it. The washing machine can move vertically upwards and downwards, hence the flexible inlet connection pipe. This allows for the lower tubes to enter the struts to clean internal surfaces as well.

The team now needed to size the washing machine's components and then determine pressure and mass flow rates through the nozzles. They also had to evaluate if the proposed design would clean sufficiently and effectively.

SOLUTION

To ensure that the design met with the client specifications, the group made use of the student version of Flownex® to simulate their design. The washing machine was split into two networks for simulation:

The system layout, which includes all flow components as well as the pipe network, which distributed the cleansing water around dirty parts.

The split networks enabled different members of the team to work on the networks simultaneously. It also allowed for closer study of flow at the nozzles on a compact network.

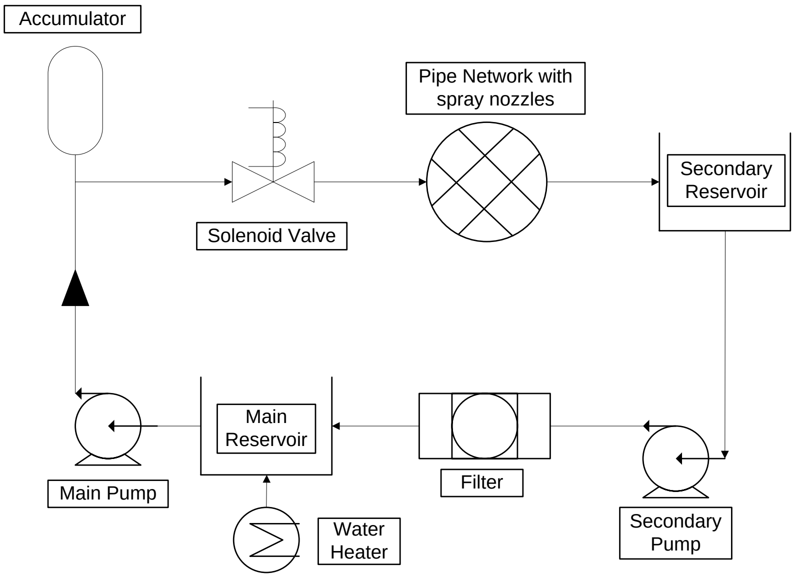

Figure 2: The layout of the washing machine system

The secondary pump draws water from the secondary reservoir. This water is filtered and then flows into the main reservoir, where it is heated to 55 °C by heating elements. The main pump circulates the water. If the solenoid valve is closed, water is pumped into an accumulator. When the valve is opened, the water flows to the pipe network with spray nozzles and cleans the dirty tubes. The function of the accumulator is to allow the pump-and-motor to run continuously and to allow for use of a much smaller pump. During the 36 seconds cycle, the accumulator is charged for 18 seconds and discharges for the remaining 18 seconds.

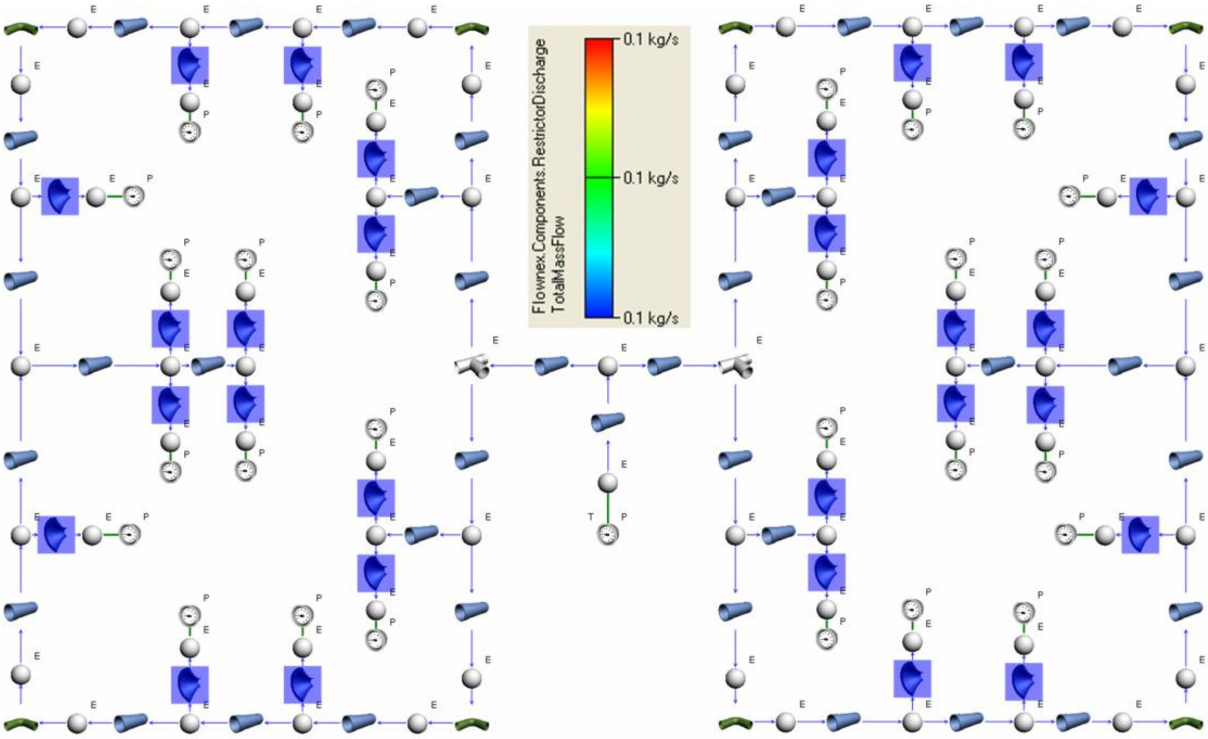

Figure 3: The Flownex® model used for analysis.

The pipe network was modelled from the solenoid valve. The nozzles were modelled as restrictors, with their exits at atmospheric pressure. Pressure at the flexible inlet hose was specified as 6200 kPa, which is the pump outlet pressure.

The benefits of using Flownex® for the simulation were:

- Tedious manual calculation of pressures and flow rates at the nozzles were avoided.
- The team could accurately determine where to place the nozzles to ensure that the flow is evenly distributed through use of the designer feature in Flownex®.
- The cyclic operation for the washing machine could be fully simulated.
- Performance characteristics of the new system could be compared to the old system in the design phase. This helped to ensure that the final design performed satisfactorily. The earlier design changes are made the more affordable the changes are.

A result layer shows the results from the simulation. Mass flow rates at the nozzle are shown to be evenly distributed, averaging 0.102 kg/s.

With the help of the Flownex®, the team was able to achieve the following:

- The optimum point of the system was determined to be 6.2 L/min per nozzle at 60 bar.
- Water consumption rate increased by 6%, but total consumption is lowered due to shorter cycle times.
- 86% direct spray coverage against ~28% for the old system.
- Impact force of the water increased 2.87 times.

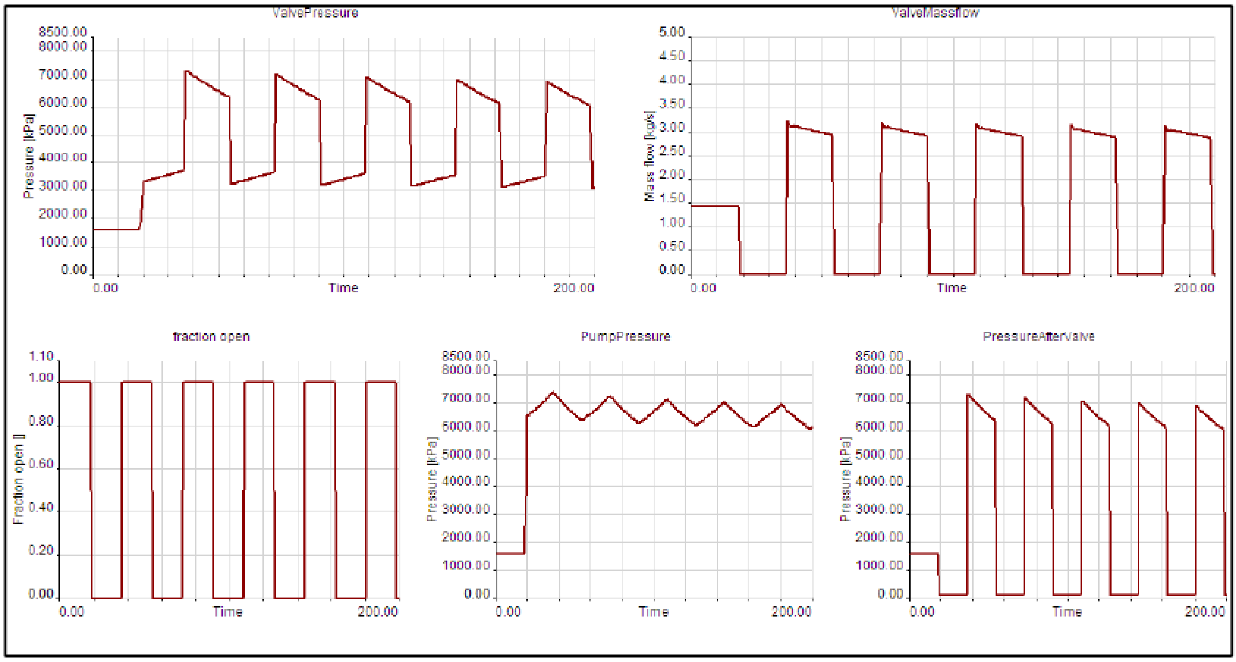

Figure 4: Graphs displaying results of the system simulation.

Starting at the bottom left of the figure and going anti-clockwise, the graphs are: 1) the fraction that the solenoid valve is open. It fully opens and fully closes every 18 seconds. 2) Pressure at the pump exit. Use of an accumulator soothes this graph. When the simulation period is extended, the graph becomes even smoother as the initial transient characteristics die out. 3) Pressure at the exit of the solenoid valve. Results from this graph were important in selecting the solenoid valve to use. 4) Mass flow rate through the solenoid valve. An average of the graph's crests is close to the 2.8 kg/s minimum flow required. 5) Pressure at the inlet of the solenoid valve. It peaks at 7300 kPa right after the valve is closed. It then drops gradually as flow is diverted to the accumulator. When the valve opens again, it suddenly drops again.

SUMMARY

A team of students designed a new industrial washing machine for CI-Gabriel in an academic study. The team simulated their design in Flownex®, which they used to determine the optimum operating point of the system. They also used the results from Flownex® to position the nozzles and ensure that the flow was evenly spread out. Simulation of the cyclic operation of the washing helped the team determine water and energy consumptions, as well as the overall efficiency of the washing machine. Through use of Flownex®, the team was able to determine if the design met the required specifications, and also realised significant improvements to the previous industrial washing machine system.

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PROFILE

In Global Engineering Teams (GET), a multidisciplinary intercultural team which consists of at least 4 students works on a project that is offered by an industrial company. Academic partners include The Technical University of Berlin in Germany, Sociesc in Brazil, University of Stellenbosch in South Africa as well as partners in Botswana, Nicaragua and Puerto Rico. Partners from industry include Daimler-Chrysler, Whirlpool, CI-Gabriel, Inpro, BMW etc. These projects are typically design or research projects, which are to be completed within an academic calendar year. The team that used the Flownex® software to design an industrial machine consisted of 6 members, 2 from South Africa, 2 from Germany and 2 from Brazil.

www.global-engineering-teams.org

Figure 5: The industrial washing machine used by CI-Gabriel.