Marathon: Check Valve Outlet Design

Overview
Marathon Petroleum Company LP (MPC) transports and distributes undyed diesel and red dyed diesel. The red dye is used to identify non-taxed diesel fuel and heavy fines ensue for a driver of a vehicle containing fuel with this red dye. After filling a vehicle with this dyed fuel, the dye has to be flushed from the system just in case the next vehicle requires non-dyed fuel. In the additive injection system there is a check valve that releases the red dye into a 4-inch pipe of diesel flow. The red dye shuts off towards the end of the fill up and diesel is used to flush the system. Currently, all of the red dye does not flush out of the system.

Objectives
The team’s objective is to modify a Swagelok check valve that is used to inject a red dye additive into diesel flow. This modification is necessary to make the red dye wash out of the valve and to ensure that there is no red dye stagnating in the check valve cavity.

Approach
- Customer needs and requirements were gathered through numerous meetings and a site visit.
- A patent and existing product search showed that this is a unique problem with no current solution.
- Brainstorming as a team and with the sponsor was used as a form of concept generation.
- SolidWorks was used for CFD modelling on the check valve concepts.
- Multiple prototypes were machined from aluminium to cut down on cost of the actual valves.
- These valves were exact replicas of the control Swagelok check valves.
- Extensive testing was done on each of the machines valves.
- This testing was done in a flow simulator designed by the team that replicates the flow of diesel fuel.
- Through the use of clear PVC pipe the team was able to time how long a check valve took to flush out after injection stopped.
- Each valve was timed a total of 6 times and some valves in up to 3 orientations.
- A table of time data was generated and bar graphs were made to easily see which valves performed the best.

Outcomes
- The ported design was determined as the best design.
- The performance of this check valve improved by 70% from the control.
- The modification is simple to machine.
- The modification does not reduce service life.

Control Swagelok Check Valve

Modified Ported Check Valve