MIXING FOR LACT UNITS

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INTRODUCTION

The purpose of this report is to verify that mixing by centrifugal pump and the KAM SMP Static Mixing Plate will produce a homogenized flow in compliance to API MPMS Chapter 8.2 on an existing truck unloading riser. Toward that end, CFD simulations were created to model flow based on the existing system from pump to sampling point, including determining C1/C2 values at the sampling point. These models were based on the configuration in Fig. 1. Flow data (Fig. 2) is based on an internal field report. Scenarios from minimum to maximum flow rate were considered using a density value of API 70 – the worst-case value for mixing. Mixing is most difficult in these scenarios due to the higher disparity in density of the oil and water. Cases with and without the KAM SMP Static Mixing Plate were tested to demonstrate mixing contributed by the static mixer. As further discussed in the Results section, KAM's SMP and pump combination produce C1/C2 values greater than 0.9 as required by API 8.2. Mixing from the pump alone was deemed insufficient.

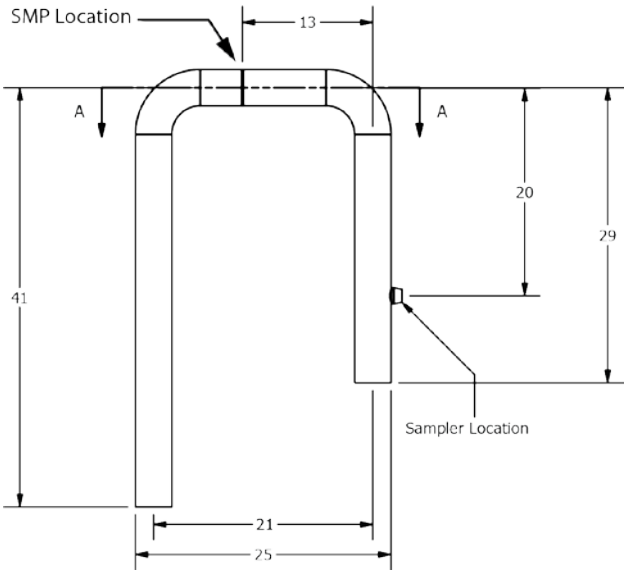

Fig. 1 Piping configuration and SMP placement

Pipe Size (NPS)	3"		
Oil API (°)	70		
Oil Density (kg/m3)	700		
Oil Viscosity (cP)	0.6		
Max. Water (Vol. %)	5		
Operating Cases	Min. Flow	Norm. Flow	Max. Flow
Flow Rate (BPH)	200	280	350
Velocity (ft/s)	6.1	8.5	10.6

Fig. 2 Flow conditions

RESULTS

Modeling without static mixing shows a requirement for a static mixing element in order to achieve a C1/C2 greater than .9 as required by API 8.2 (Fig. 3). Mixing increases with increasing velocity to 180 BPH, after which point mixing decreases slowly up to the maximum at 350 BPH. This is because increased flow rate through a bend tends to push water into the pipe wall.

C1/C2 Values

	Min. Flow	Norm. Flow	Max. Flow
Without SMP	0.90 - 0.96	0.88 - 0.96	0.87 - 0.95
With SMP	0.99	0.98	0.97

Fig. 3 C1/C2 Calculations

In Fig. 4, the maximum flow SMP case is shown to illustrate mixing, while the other flow cases follow similar trends. The vector velocity profiles show the magnitude and direction of flow. The colored portion represents velocity magnitude, while the white lines represent flow path at the given point. The streamline plots further show the paths taken by the fluid, while also showing velocity magnitude in color.

The vector velocity profiles in these images (Fig. 4) demonstrate the flow agitation induced by KAM's SMP. The colored portion show the increased velocity around the SMP which along with pressure drop promotes uniform water droplets that allow for a stable, homogenized flow. The white lines shows the vortices around the SMP which contributes to dispersion of water across the pipe cross-section. The streamlines model the swirled mixing immediately following the SMP.

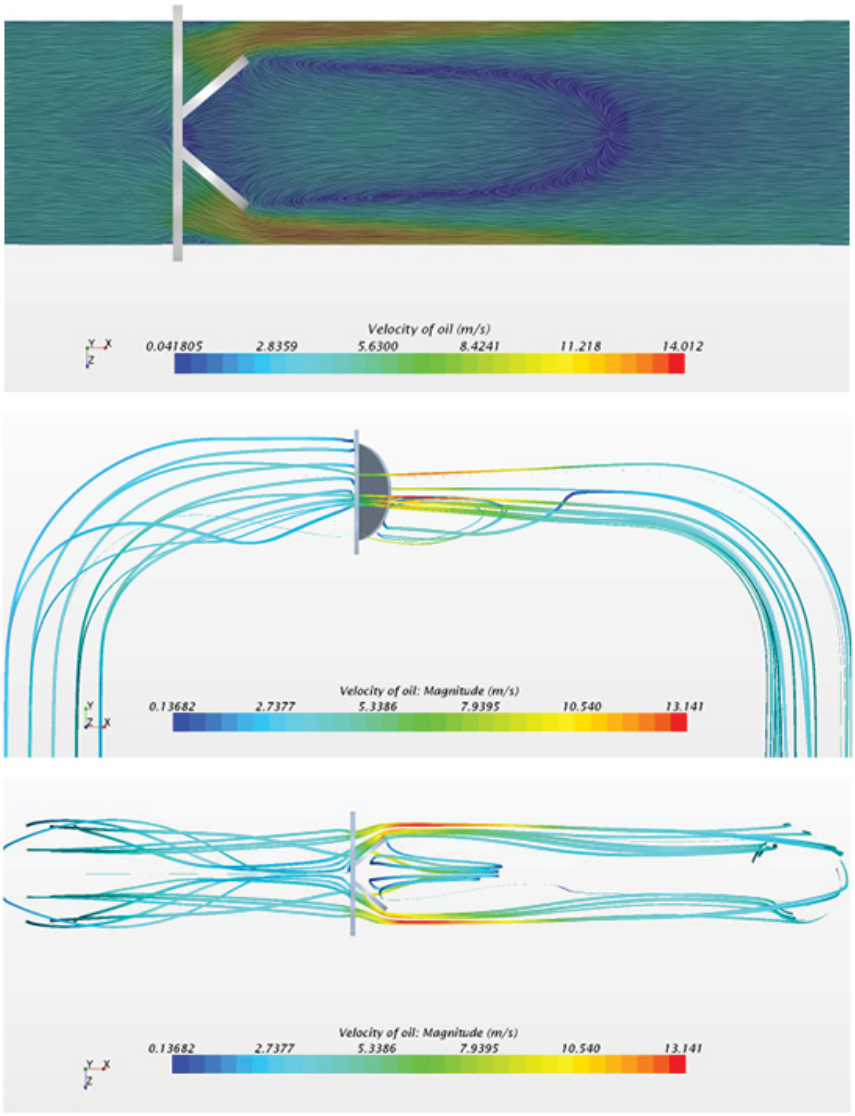

Fig. 4 CFD Images

CONCLUSION

Kam Controls recommends the use of a static mixer as a safeguard against the inherent randomness of centrifugal pump mixing, which on its own would occasionally fail API 8.2 standards for a representative sample. The data summary in the Results section demonstrates that a centrifugal pump and the KAM SMP together offer the best mixing, while a centrifugal pump alone offers a range of results that drift into unacceptable mixing.