Debottlenecking and CFD Studies of High and Low Pressure Production Separators

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NATCO

The objectives of the engineering study were to:

- **Evaluate each vessel's performance at the production rates expected in 2009.**

  - **Weir Height**
  - **Weir Location**
  - **Liquid Level Settings**
  - **Baffle Design**
  - **Baffle Locations**

The objectives of the CFD study were to:

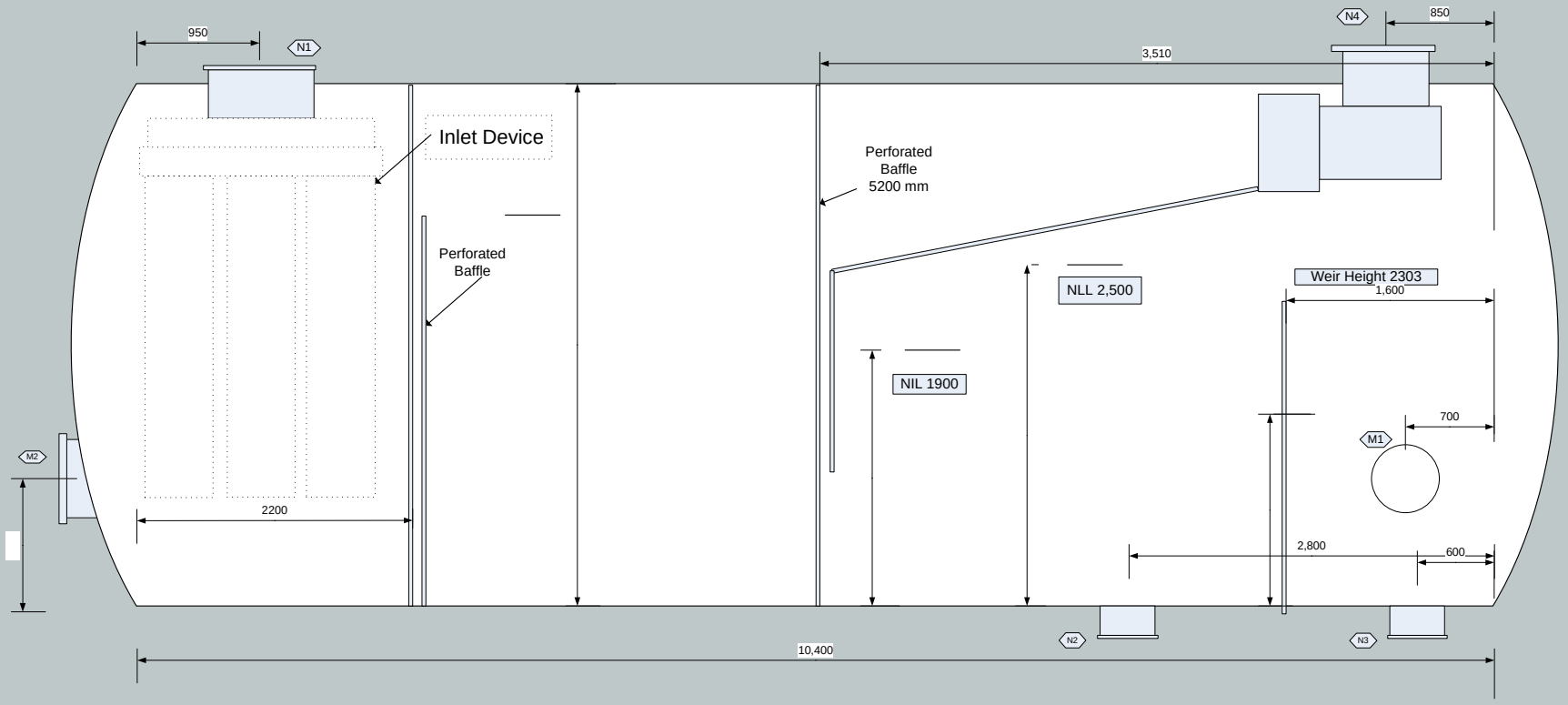
- **Demonstrate**
  - **Volumetric Utilization**
  - **Interfacial Flow Behavior**
  - **Both Inlet and Low Pressure Separators**

  - **At 2007 Production Rates, Current Geometry and**
  - **At 2009 Production Rates, Recommended Geometry**

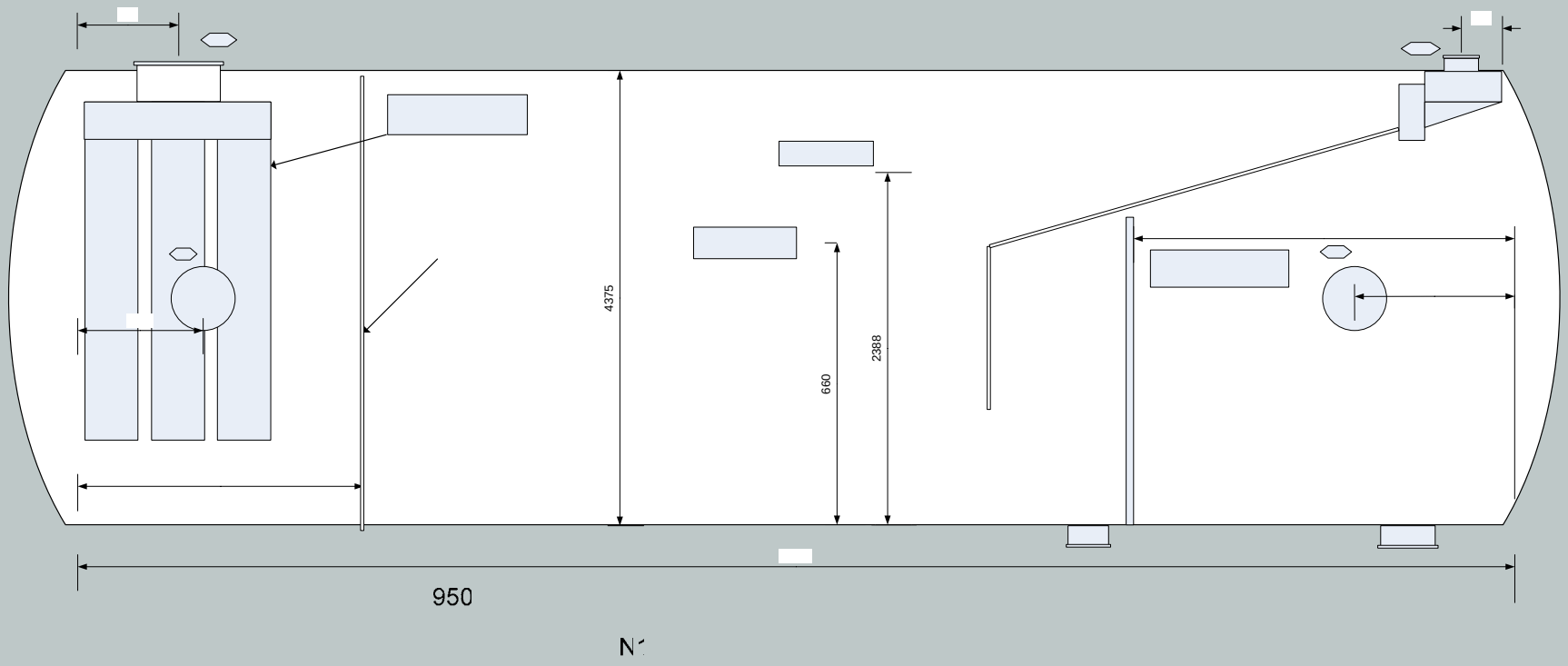
Issues of Concern

- **High BS&W**
  - **HP Separator, in 34.6%, out 15.0%**
  - **LP Separator, in 15.4%, out 5-13.0%**
- **Excessive Foam**
  - **HP Separator, 200-400mm (8-16in)**
  - **LP Separator, 400-800mm (16-32in)**
- **Liquids Carryover to Compressor Suction**
- **Operations Difficulties**
  - **Low Surge Volumes**
- **Maintain or Improve Oil/Water Separation at Increased Flow**
- **Sand Accumulation**

High Pressure Separator Drawing for Existing Vessel



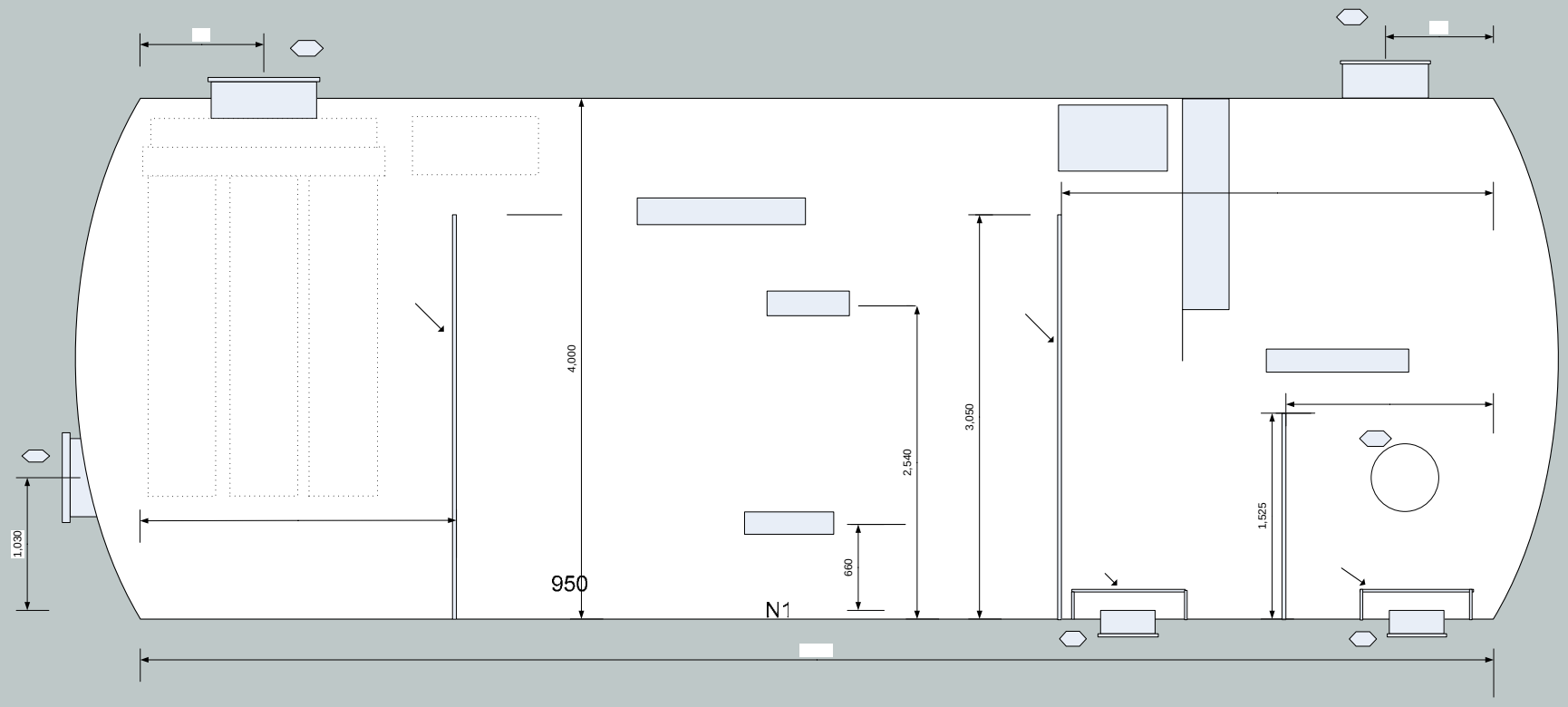
Low Pressure Separator
Drawing for Existing Vessel



HP/LP Separator Initial Conditions

- **HP Separator**
  - **Oil RT – 2.9min, velocity – 0.16ft/sec**
  - **Water RT – 13.6min, velocity – 0.03ft/sec**
- **LP Separator**
  - **Oil RT – 1.4min, velocity – 0.39ft/sec**
  - **Water RT – 32.9min, velocity – 0.017ft/sec**

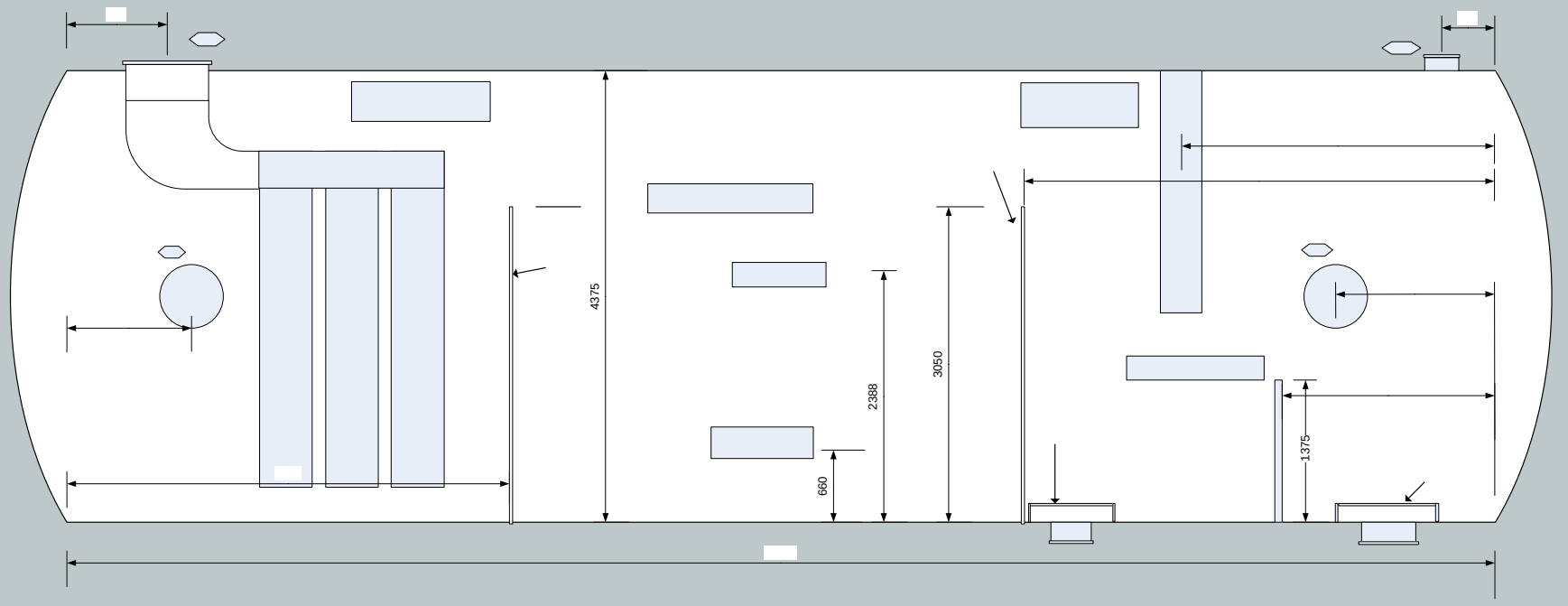
High Pressure Separator Drawing for Recommended Internal Modifications



Existing Inlet Device

Baffle Height 3,050

LP Separator Drawing for Recommended Internal Modifications



950

Improved

HP/LP Separator Recommended Conditions

- **HP Separator (Original Flow Conditions)**
  - **Oil RT – 5.8min, velocity 0.08ft/sec**
  - **Water RT – 5.6min, velocity 0.08ft/sec**
- **HP Separator (Increased Flow Conditions, 25%)**
  - **Oil RT – 5.1min, velocity 0.09ft/sec**
  - **Water RT – 5.4min, velocity 0.09ft/sec**
- **LP Separator (Original Flow Conditions)**
  - **Oil RT – 5.3min, velocity 0.12ft/sec**
  - **Water RT – 5.5min, velocity 0.11ft/sec**
- **LP Separator (Increased Flow Conditions, 50%)**
  - **Oil RT – 3.2min, velocity 0.2ft/sec**
  - **Water RT – 4.0min, velocity 0.16ft/sec**

CONCLUSIONS- RECOMENDATIONS

- Performance, Inlet and LP separators, can be improved.
- Retain Inlet Separator Inlet Device.
- Improve LP Separator Inlet Device - Severe Foaming.
- Change Perforated Plate Baffles - Improved Fluid Flow.
- Move Perforated Plate Baffles - Improved Fluid Flow.
- Change to Spillover Weir – change weir height, improve volumetric utilization.
- Change Demister Drain – into oil layer.
- Adjust Liquid Levels - similar velocities each phase.

CFD Study

- **Key Vessel Changes**
  - **Baffle Location**
  - **Weir Location and Height**
  - **Oil-Water Levels**
  - **Flow Rates**
- **Improvements in Volumetric Utilization**
- **Improvements in Liquid Flow Control**

Table 3: Volumetric Utilization of the Two Designs

	Volumetric Utilization (%) of the Liquid Phases		
	Overall Liquid Phase	Water Phase	Oil Phase
HP original	68	55	82
HP recommended	83	75	84
LP original	68	52	87
LP recommended	94	95	94

Figure 3: Volumetric utilization for the HP separator of the two designs: (original) using 2007 conditions and recommended design changes using 2009 conditions

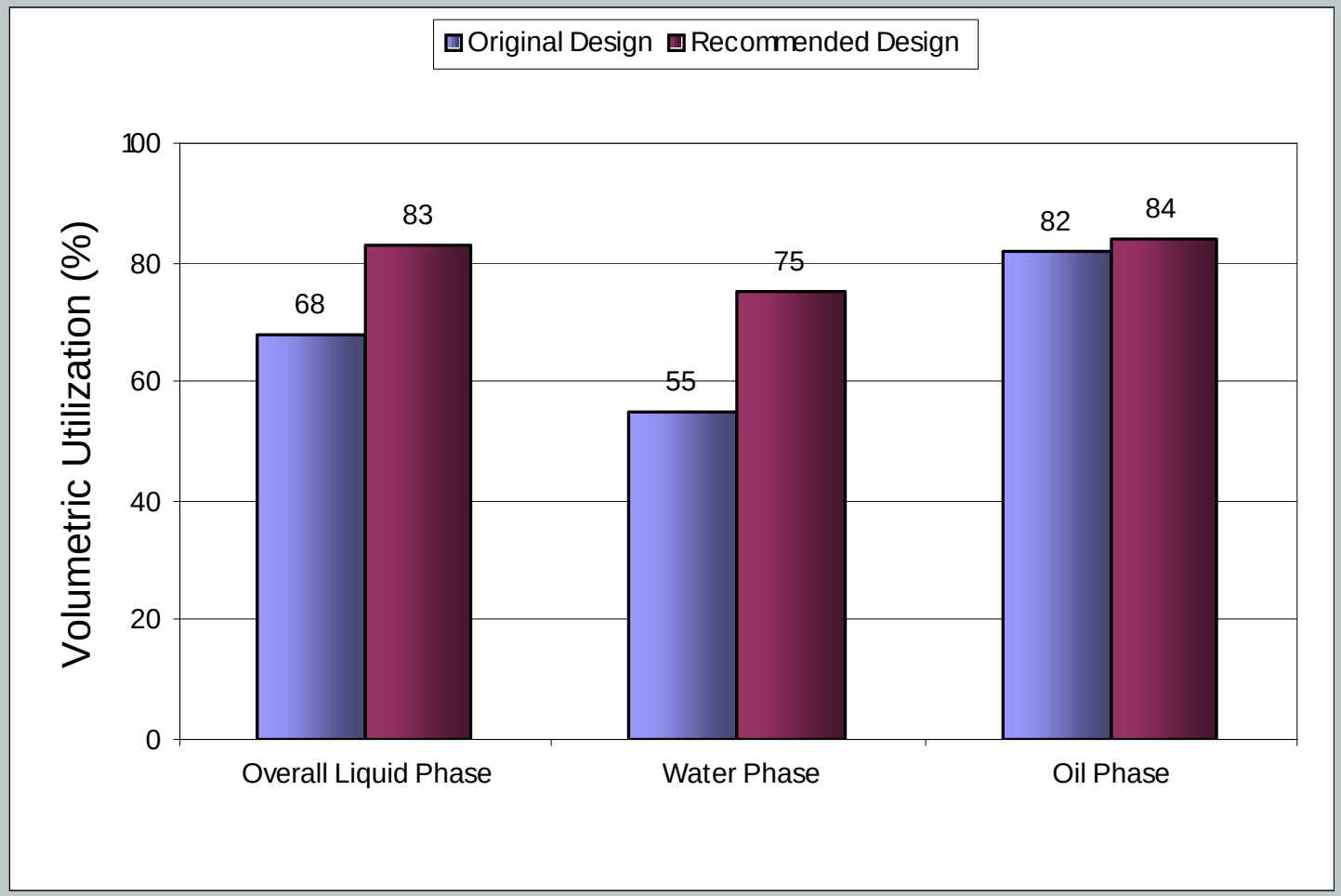


Figure 4: Volumetric utilization for the LP separator of the two designs: (original) using 2007 conditions and with recommended design changes using 2009 conditions

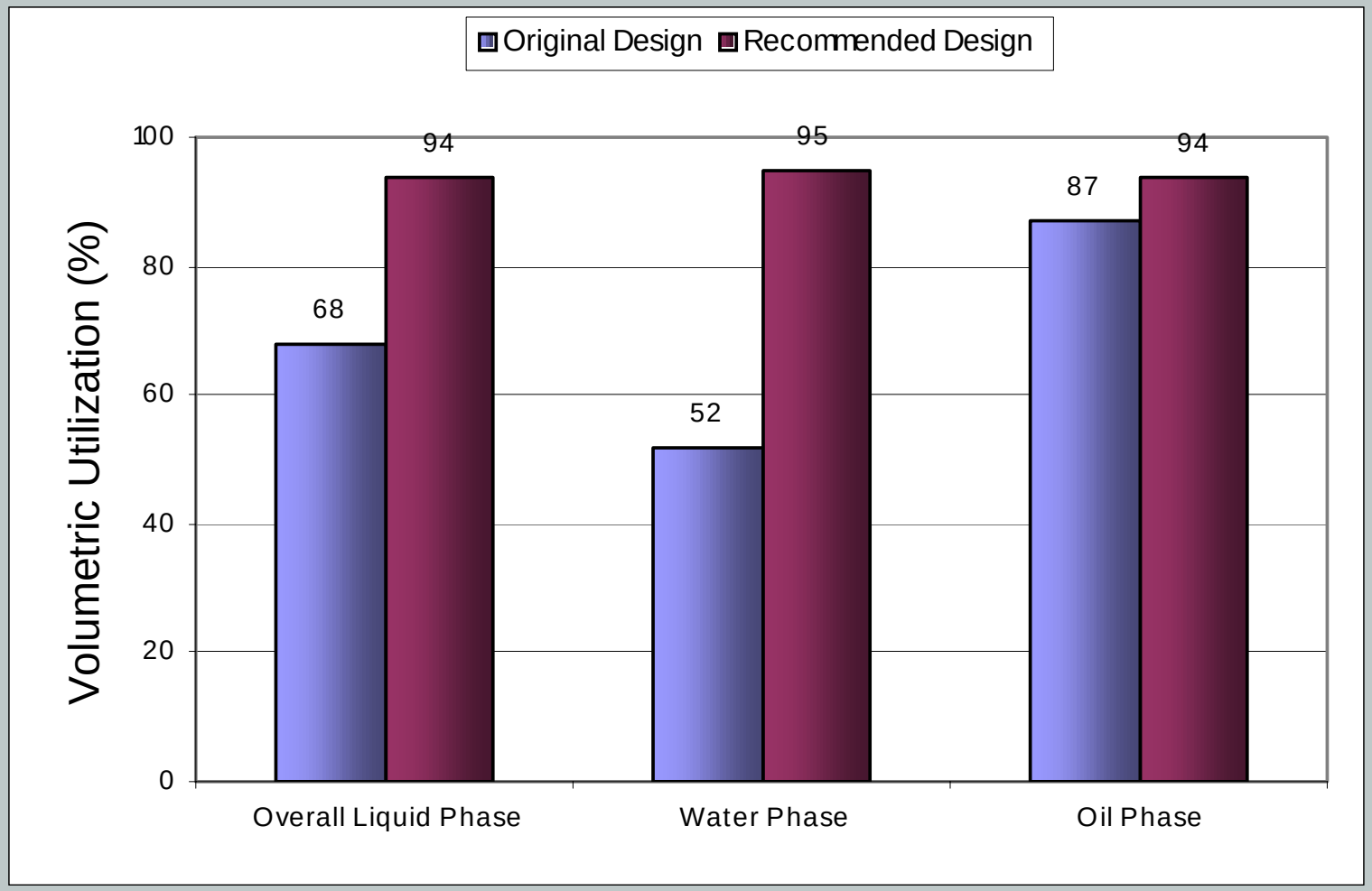


Figure 5: Pathlines colored by Velocity magnitude (M/sec) for HP separator original case showing overall flow pattern of the (a) oil phase (b) water phase. Overall volumetric utilization = 68%.

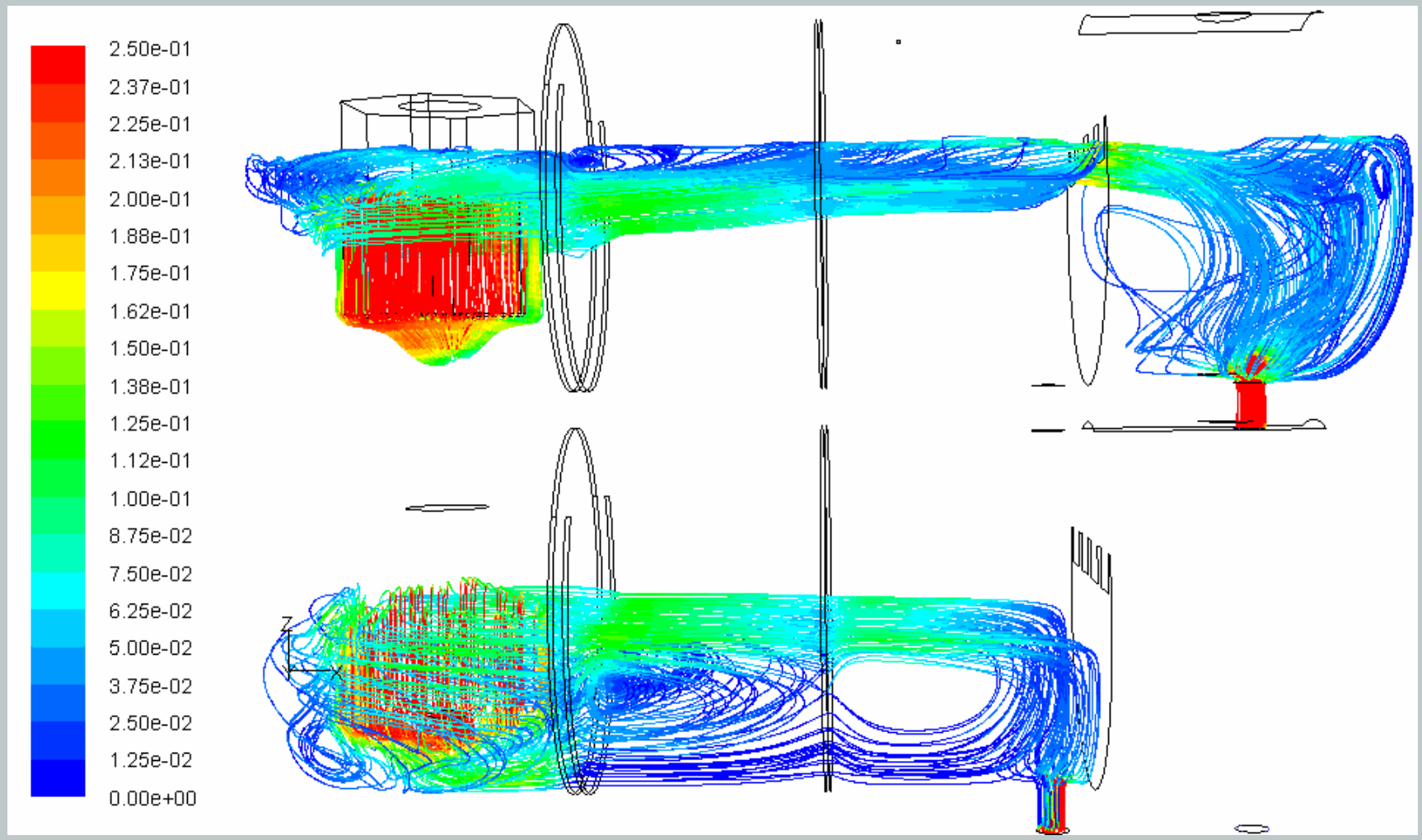
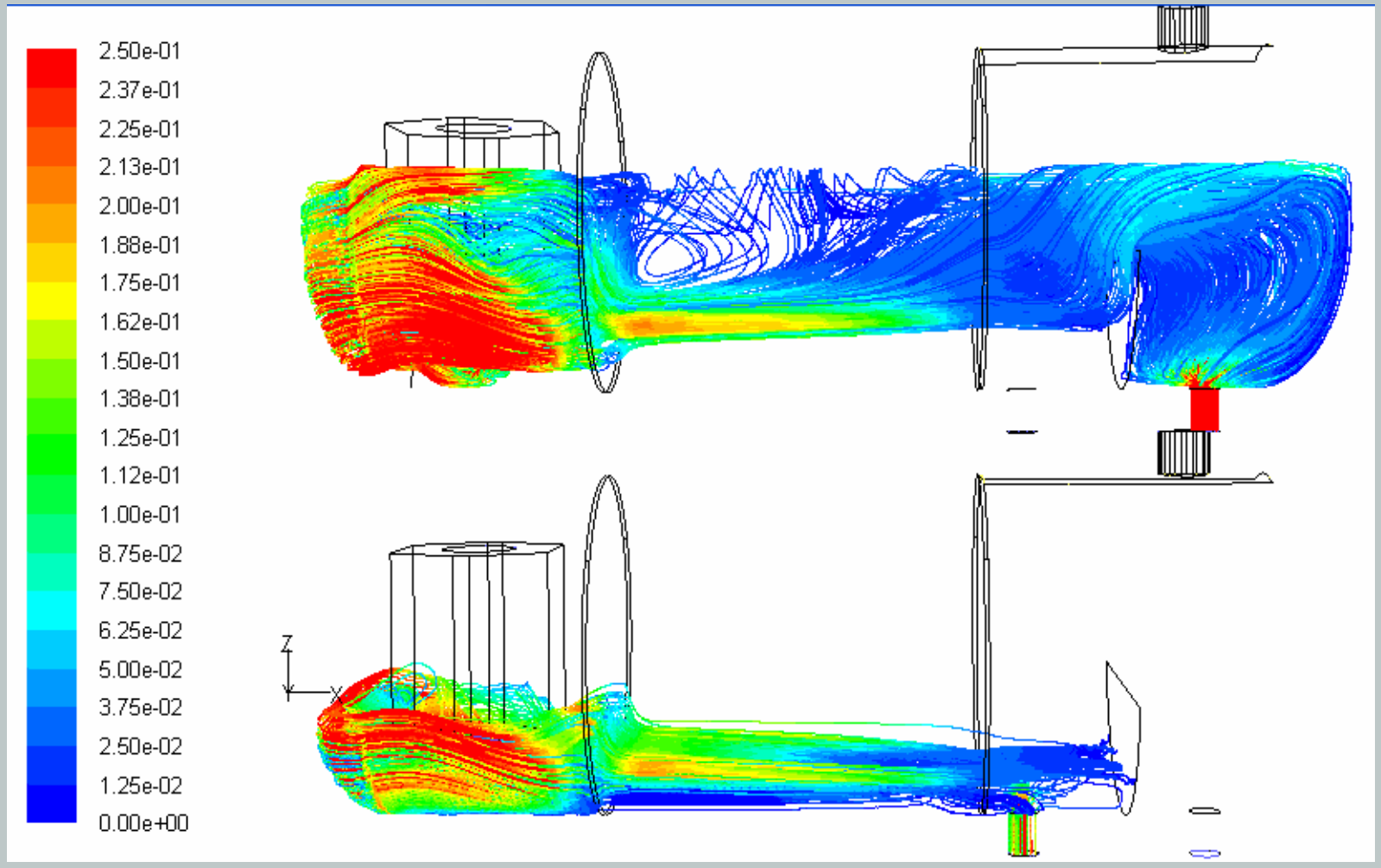


Figure 6: Pathlines colored by Velocity magnitude (M/sec) for HP separator recommended case showing overall flow pattern of the (a) oil phase (b) water phase. Overall volumetric utilization = 83%.



HP Separator CFD Observations

- Larger Oil Volume, Overall Slower Flow
- Eliminated Oil Backflow at Baffle

- Eliminated Large Water Recirculation Zones
- Eliminated Large Stratified Water Zones
- Eliminated Water Backflow at Baffle

Figure 7: Pathlines colored by Velocity magnitude (M/sec) for LP separator original case showing overall flow pattern of (a) oil phase (b) water phase. Overall volumetric utilization is 68%.

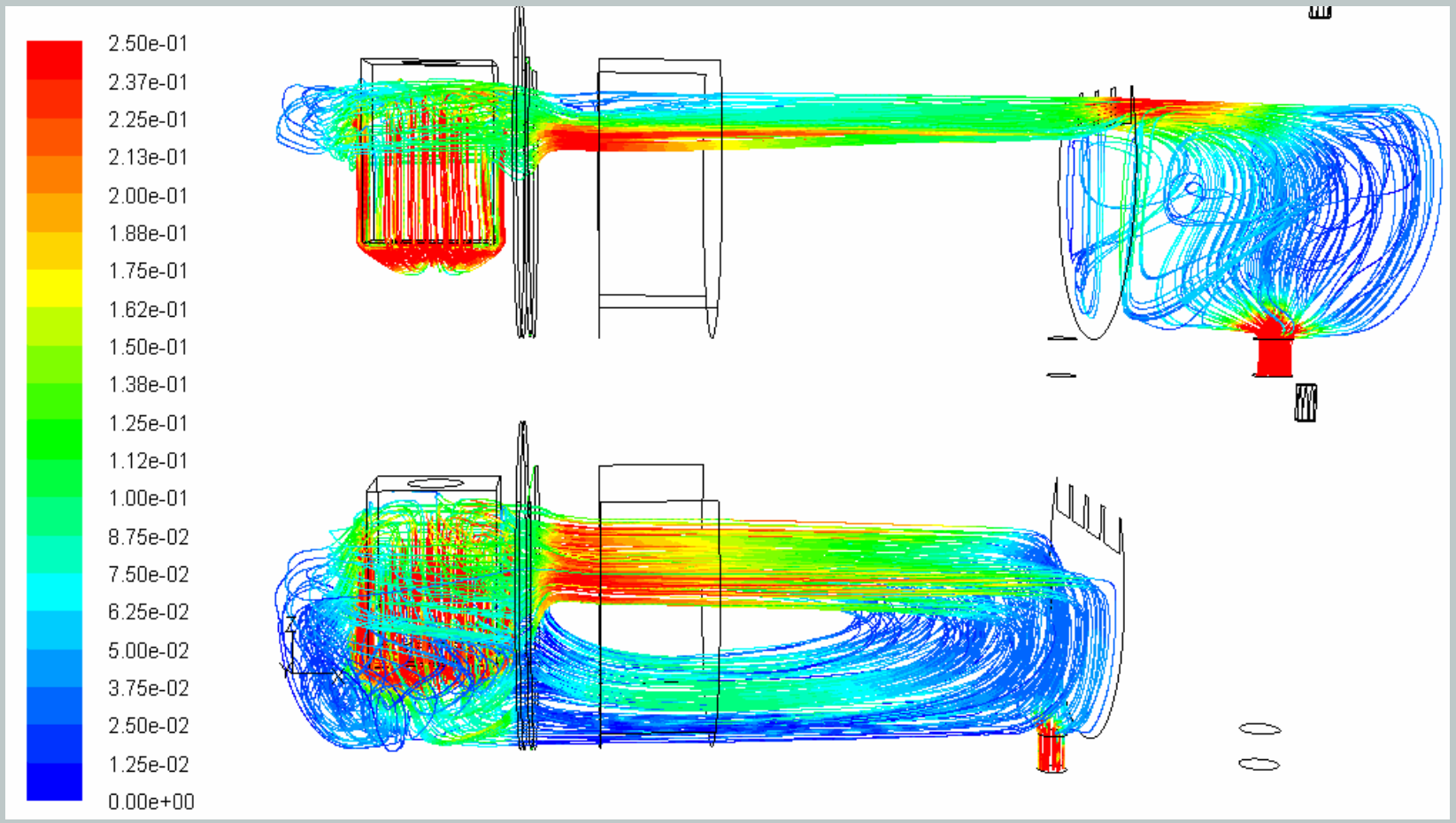
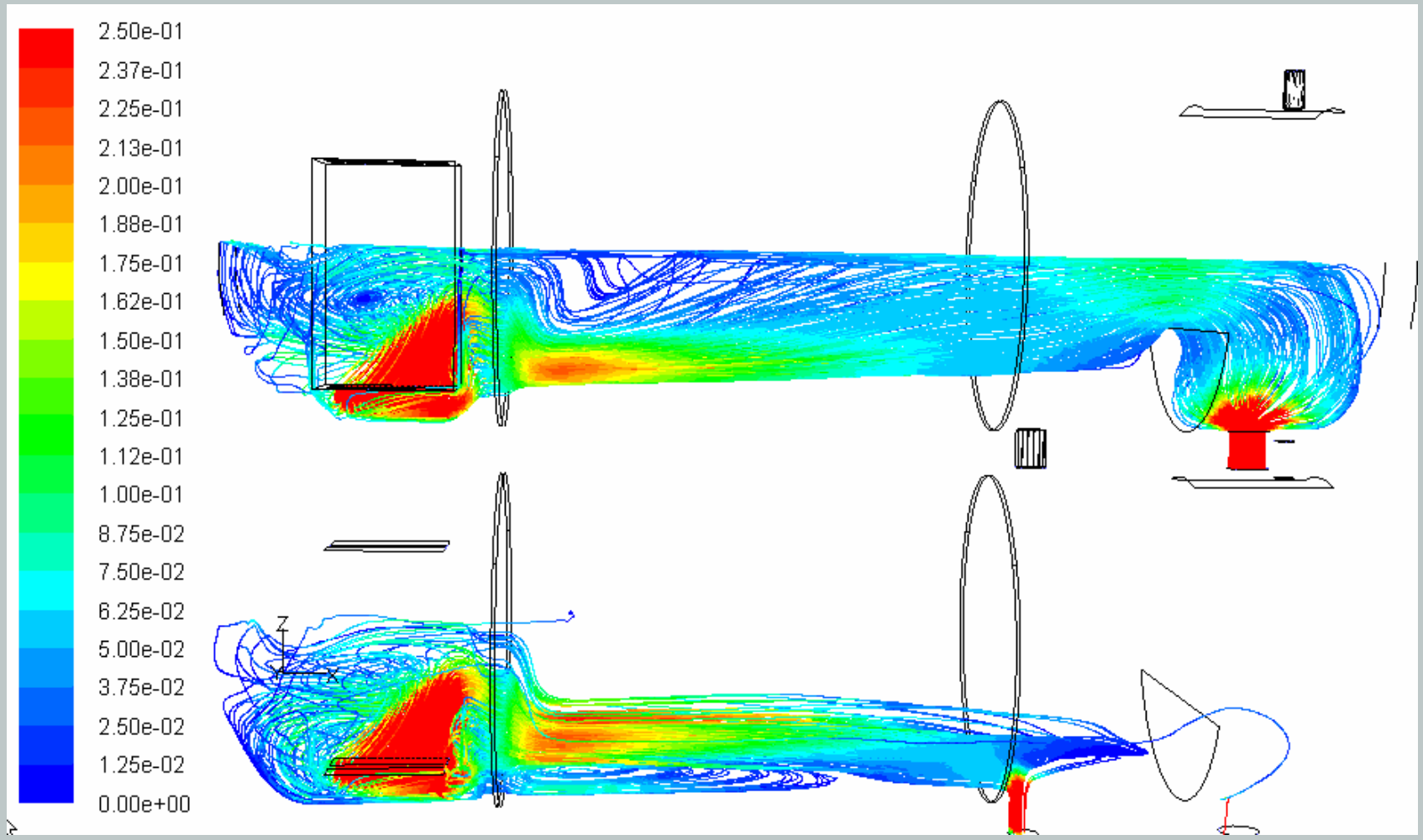


Figure 8: Pathlines colored by Velocity magnitude (M/sec) for LP separator recommended case showing overall flow pattern of (a) oil phase (b) water phase. Overall volumetric utilization = 94%.



LP Separator CFD Observations

- Reasonably Uniform Oil Flow
- Has Slower Oil Flow Zone, but no Flow Backwards
- Still Have Higher Oil Flow Zone After Baffle

- Eliminated Significant Water Recirculation Zone
- Eliminated Water Backflow Through Baffle
- Reduced Stratified Flow in Water Layer

RESULTS

- Operator reluctant to take shutdown, changes take longer than expected
- Changed LP Separators, operating 50% higher flow
- Continued difficulties with downstream water equipment
- BSW reduced 18% to 14%, but keeping oil flow high and NIL high
- Oil/Water about 100ppm, down from 500ppm, but at higher flow
- Changes working, but must remedy other water treating issues