Economic Analysis

Microbiological Control in Metalworking Fluids

Value Proposition

By providing easily and rapidly measured bioburden test results, Quench-Gone Organic-Modified (QGOM) and Deposit and Surface Analysis (DSA) test kits from LuminUltra can reduce annual fluid management costs in metalworking fluid and MWF system surfaces by 5 to 10%.

Model Assumptions

The following case study illustrates how real-time data and timely, data-driven actions translate into reduced operating costs:

- ✓ Parts per tool: 10% improvement.
- ✓ Parts per hour: 5% improvement.
- ✓ Prevention of a single D, C & R (drain, clean & recharge) event.
- ✓ Replacing 90% of culture tests (culture tests can still be useful on occasion).
- ✓ Corrective actions are performed promptly after data indicate need.

The Value of Time

Recirculating MWF degrade over time. The major contributing factors to MWF degradation include:

- Thermodynamic reactions in the region where MWF contacts tools and work-pieces
- Chemical reactions between MWF components and metal surfaces (work-piece and tailings, chips, swarf, etc.)
- Total dissolved solids that accumulate due to cycles of concentration of make-up water evaporation and replenishment
- Microbial activity:
  - Proliferation (increased number of cells; with some common types of microbes doubling every 0.5 to 1h)
  - Microbial water products (acids, biopolymers, biopolymers, etc.) react with MWF components; selectively depleting amines, corrosion inhibitors, non-amine buffering agents, and other functional additives.
  - Microbes and large molecules that become the bio-aerosol component of MWF mists cause allergenic diseases including industrial asthma and hypersensitivity pneumonitis.
  - Biomass accumulation plugs filters and fouls the recirculation system.
  - Microbial volatile organic chemicals (MVOC) contribute to both MWF foul odors and respiratory health risk.

Most commonly used MWF condition monitoring tests produce results within minutes. MWF concentration, pH, alkalinity, total dissolved solids (conductivity), tramp oil concentration and dirt-load each can be tested in less than five minutes.

The traditional test for microbial contamination is the culture paddle. Fast growing microbes will form colonies in 16 to 24h. Slower growing microbes may require a week or longer to form colonies. Either way, by the time data are available, the MWF system's microbiology has had substantial time to change. The test results do not provide an accurate indication of the current state of the MWF. This means:

✗ Corrective action is delayed; the delay can be the difference between maintaining the MWF in good condition and having to drain, clean & recharge (D, C & R) the system.

✗ Microbiological test data are asynchronous with all other condition monitoring test data. Consequently, corrective actions can't be performed holistically. For example a variety of factors can cause the pH to fall below the lower control limit. If the primary cause is biological activity, adjusting pH without treating for microbial contamination is an insufficient corrective action and multiple treatments are likely to be needed.

✗ At facilities where fluid management contractors control additive additions, the fluid manager must make a second visit to the site to perform corrective actions in response to the microbiological data.

Cost Impact Analysis

For the following case study we will make the following assumptions:

- Manufacturing facility with a 10,000 gal central system
    - Target MWF concentration = 5% v/v
    - MWF concentrate cost = $3.50/gal
- 100 parts made per hour at $50/part.
- Fluid managed by service/compounder supplier
    - Cost per fluid manager visit = $1,000 (includes travel, salary & benefits, and cost of condition monitoring tests)

The cost of a **single D, C & R (drain, clean & recharge) event** required to eliminate microbial contamination is calculated as follows:

Item	Cost	
	Per Unit	Extended
Waste treatment	$2.50	$25,000
Labor (4 workers x 8 hours)	$15.00	$480
MWF Concentrate (500 USgal)	$3.50	$1,750
Lost Production (100 parts/h; 8 hours lost)	$50.00	$40,000
Total	**-**	**$67,230**

The cost of a **10% tool life reduction** from uncontrolled microbial contamination is computed as follows:

Item	Value
Cost per tool	$500
Parts per tool	$250
Part per hour	$100
Parts per year (2688h production/y)	268,800
Tools per year based on parts per year	1075
Total Tools cost per year	$537,600
Cost impact of 10% tool-life decrease	
Parts per tool	225
Tools per year based on parts/y	1,195
Incremental tool cost per year	**$59,733**

The cost impact of a **5% reduction in production speeds** from uncontrolled microbial contamination is computed as follows:

Item	Optimal	5% Reduction
Parts per hour	100	95
Parts per year	268,800	255,360
Value per part	$50	$50
Production gross revenue per part per year	$13,440,000	$12,768,000
Cost impact of 5% productivity reduction	**-**	**$672,000**

Finally, the cost of making **10% additional fluid manager site visits per year** due to uncontrolled microbial contamination is computed as follows:

Item	Cost	
	Per Unit	Extended
Weekly condition monitoring site visits	$1,000	$48,000
Impact of 2nd visit for microbial control actions 10%	**$1,000**	**$5,000**

Tallying up these costs results in the following annual savings:

Impact	Cost
Avoid 1x D,C, and R event	$67,230
Avoid 10% reduction in tool life	$59,733
Avoid 5% reduction in production rate	$672,000
Avoid 10% more fluid manager visits	$5,000
Total cost benefit	**$803,963**

Cost Benefit Analysis

The incremental cost of substituting ATP test for 90% of culture tests and the annualized return on that investment is summarized in the following table:

Item	Cost	
	Per Unit	Extended
Culture paddles (1/wk x 48 production weeks)	$2.50	$120
LuminUltra Start-up Kit (year 1 costs)	$7,200	$7,200
QGO-M test supplies	$13.00	$624
Incremental cost to switch to QGO-M	$10.50	$504.00
Incremental cost; year 1	-	$7,212
	$	%
ROI year 1	**$790,000**	**158,000**
ROI year 2 and beyond	**$800,000**	**159,000**

Conclusion

For a single 10,000 USgal system using tools at $500 each that produce 250 parts/tool valued at $50/part with normal production rates of 100 parts/hour, the cost impact of inadequately controlled microbial contamination can approach $1 million annually. The first year return on investment for a LuminUltra QGOM start-up kit can be 100x or more! Can you afford not to be using QGO-M test kits?