Technical Case Study

LACTROL®

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Lactrol antimicrobial treatment saved an ethanol producer nearly $1,600,000 per year in lost revenue.

Phibro EthanolPerformanceGroup

Benefit

LACTROL® antimicrobial treatment saved an ethanol producer nearly $1,600,000 per year in lost revenue on this one incident. If this situation were not brought under control with LACTROL, the cost in lost profits would have been much higher.

This is a review of an actual customer situation which demonstrates the benefits of utilizing Phibro's antimicrobial product, LACTROL®. The plant we are discussing is a batch process and has a nameplate capacity of 50 MM gal/yr of fuel ethanol. It is a dry mill process that recycles the backset to the front of the plant.

Problem

We were contacted by this particular plant because they determined that they had a severe problem with microbial infection that was affecting the operation of the plant. This plant had been online for about a year when they contacted Phibro's Ethanol Performance (EPG) group to place an order for LACTROL. The table below shows how their operation had been impacted. All values were from customer supplied high performance liquid chromatography (HPLC) data.

TABLE 1

Parameter	Normal Value	Values with Infection (wt %)	Increase/(Decrease) from Normal (wt %)
Lactic Acid		0.15	0.72	0.57
Acetic Acid	Below detection	0.54	.54
Glycerol	1.0	1.7	0.7
Glucose	0.2	8.76	8.56
% Ethanol by wt.	13.5	8.6	(4.9)

The program they were utilizing was a blended antibiotic (Penicillin -75%,Viginiamycin -15%, and Streptomycin -10%) that was being fed into each yeast propagator and fermentor at .59 ppm. This went on for nearly 14 days before plant personnel initiated the feed of LACTROL.

Plant Operation Data

- 50 MM gal/yr ethanol capacity, batch process
- Normal pH going into fermenter is 5.0-5.2
- pH of yeast propagator is 4.0-4.2
- Yeast propagator capacity is 14,000 gallons with a working volume of 12,000 gallons
- Fermenter fill capacity is 550,000 gallons
- Dosing of 0.59 ppm blended antibiotic to yeast propagator and fermenter

The LACTROL was added to both the yeast propagator and the fermenter at 0.69 ppm*. The plant also continued to feed their current blended antibiotic regimen at pre-infection rates of 0.59 ppm*. Within ten days after the initiation of the LACTROL feed, the plant saw the following results and saw further reductions after a full month. Those results are summarized in Table 2.

TABLE 2

	Normal Value	Values with infection (wt %)	10 days after adding LACTROL (wt %)	1 month after adding LACTROL (wt %)
Lactic Acid	0.15	0.72	0.2-0.25	.15
Acetic Acid	Below Detection	0.54	0.1-0.15	0.05-0.07
Glycerol	1.0	1.7	1.4	1.0
Percent Ethanol by wt.	13.5	8.6	?	13.3

*Note: These dosages were calculated as follows: *[(wt. of antibiotic in Propagator + wt. of antibiotic in fermenter)]**108,000 gals/(*wt. of liquid volume in fermentor*)

Solution

The customer was so pleased with the performance of the LACTROL program that they continue to feed it on a regular basis in order to prevent any future problems. The bullet points in the appendix outline the calculations used to estimate the theoretical loss in ethanol production based on the use of HPLC data.

- Normal ethanol production is 152,490 gallons per day
- Production rate of ethanol during infection was 97,137 gallons per day
- Daily loss of ethanol production was 55,353 gallons per day
- During period of severe infection (14 days), 774,942 gallons of ethanol product was lost
- At $2.05 per gallon (current price as of writing) this is $1,588,631

Other Effects on Plant Operation Due to Infection

- Increased residual sugars going to distillation slows down efficiency and plant throughput.
- Higher levels of sugar/protein in mash solids react in the "Maillard Browning" reaction. If recycled as backset, it can further inhibit the yeast.
- Residual sugars in any of the tanks after distillation can be a good source for bacteria.

Plant data was utilized to calculate actual economic impact.

Appendix - Details of Theoretical Calculations

Below is a summary of the calculations that could be utilized to estimate the potential benefit this customer received.

Stoichiometry

- Major by-products that yeast ferment from glucose (either separate or in combination)

1 mole glucose → 2 moles glycerol

→ 2 moles acetic acid

→ 2 moles ethanol

Theoretical Yield

- Major by-products that bacteria *(Lactobacillus)* make from glucose (either separate or in combination)

1 mole glucose → 2 moles lactic acid
→ 2 moles acetic acid
→ Other by-products

Theoretical Yield

Molecular weights of by-products

- Glycerol – 92.14 grams/mol
- Ethanol – 46 grams/mol
- Glucose – 180 grams/mol
- Acetic Acid – 60.06 grams/mol
- Lactic Acid – 90.08 grams/mol

Example - Effect of glycerol production on ethanol loss.

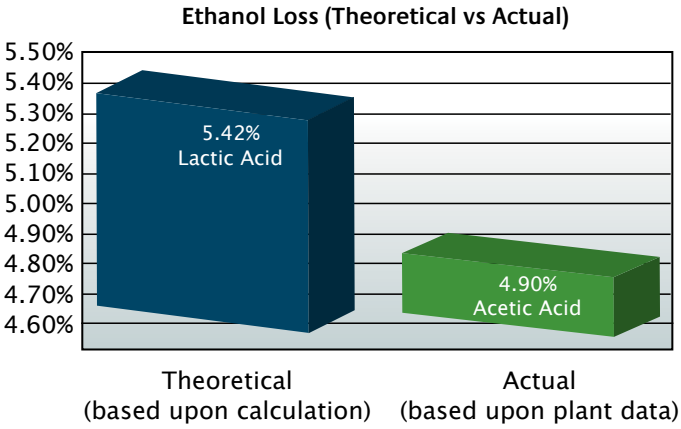
REFERENCE TABLE 1

- 0.7 grams/100 ml- increase in glycerol

$$\frac{0.7 \text{ grams}/100 \text{ ml}}{92.14 \text{ grams/mol}} = .0\ 076 \text{ mol} \times 46 \text{ grams/mol} = 0.35 \text{ grams}/100 \text{ ml} = 0.35\% \text{ calculated ethanol loss}$$

If we continued these calculations for lactic acid and acetic acid, we could determine the cumulative effect on ethanol production. This would be the net impact on ethanol loss as shown in graph 1 below.

GRAPH 1



Conclusion

The theoretical calculation showed accuracy within 10% of the actual plant data. Contact Phibro's EPG to help you determine how much money LACTROL could potentially save you today.

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