# LACTROL®

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Phibro®
PhibroChemDivision

## Benefit

LACTROL® antimicrobial treatment saves 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® antimicrobial, 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 PhibroChem'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 PhibroChem's Ethanol Performance group to place an order for LACTROL® antimicrobial. The table below shows how their operation had been impacted. All values were from customer supplied HPLC data.

**Table #1**

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

The current program that they were utilizing was a blended antibiotic (Penicillin-75%,Virginiamycin-15%, and Streptomycin-10%) that was being fed into each yeast propagator and fermentor at 0.59 ppm. This situation had been going on for nearly 14 days before plant personnel initiated the feed of LACTROL® antimicrobial.

## Plant Operating Data

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

The LACTROL® antimicrobial was added to both the yeast propagator and the fermentor 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® antimicrobial feed, the plant saw the following results and saw further reductions after a full month. Those results are summarized in Table 2.

Ethanol Performance Group

Technical Case Study

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

**Table #2**

| | Normal Value (wt %) | 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 | 0.15 |
| Acetic Acid | Below Detection | 0.54 | 0.1-0.15 | 0.05-0.07 |
| Glycerol | 1.0 | 1.7 | 1.4 | 1.0 |
| Glucose | 0.2 | 8.76 | - | 0.2 |
| % Ethanol by wt. | 13.5 | 8.6 | - | 13.3 |

## Solution

The customer was so pleased with the performance of the LACTROL® antimicrobial 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 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; lost ethanol yield and decreased still efficiency.
- Higher levels of sugar and protein in mash solids react in the still at higher temperature to form "Maillard Browning" products. If recycled as backset, these products can further inhibit yeast.
- Residual sugars in any of the tanks after distillation can be a good source for bacterial growth.

# Appendix-Details of Theoretical Calculations

Below is a summary of the calculations that could be utilized to estimate the potential benefit this customer received. Plant data was utilized to calculate actual economic impact.

## Stoichiometry

- Major byproducts that yeast ferment from glucose (either separate or in combination).

1 mole glucose ➡ (up to 2 moles glycerol maximum)
➡ (up to 2 moles acetic acid maximum)
➡ (up to 2 moles ethanol maximum)

## Theoretical Yield

- Below are the major byproducts that bacteria (Lactobacillus) make from glucose (either separate or in combination).

1 mole glucose ➡ (up to 2 moles glycerol maximum)
➡ (up to 2 moles acetic acid maximum)
➡ (up to 2 moles other byproducts maximum)

## Theoretical Yield

Molecular weights of byproducts

- 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

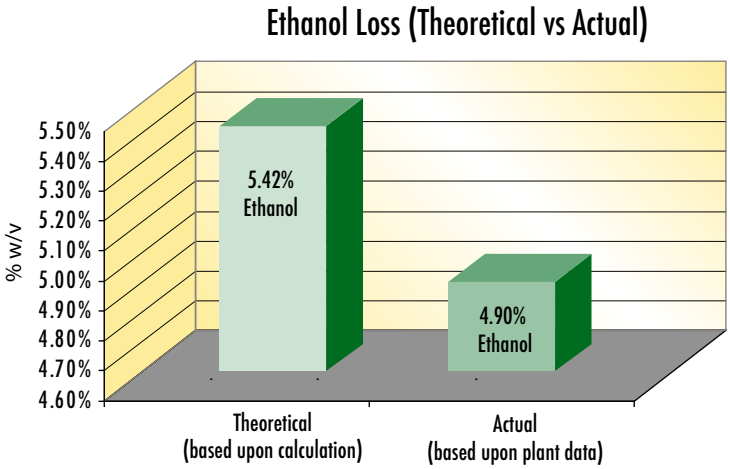
*Example - Effect of glycerol production on ethanol loss.*

Reference TABLE #1.

- 0.7 grams/100 ml-Increase in glycerol (due to infection)

$$\frac{0.7 \text{ grams}/100 \text{ ml}}{92.14 \text{ grams/mol}} = 0.0076 \text{ mol}/100 \text{ ml} \times 46 \text{ grams/mol} = 0.35 \text{ grams}/100 \text{ ml} = 0.35\% \text{ (w/v calculated ethanol loss)}$$

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 the graph below.




## Conclusion

The theoretical calculation showed accuracy within 10% of the actual plant data. Contact Phibrochem to help you determine how much money LACTROL® antimicrobial could potentially save you today!

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*A Division of Phibro Animal Health Corporation*

65 Challenger Road, Third Floor, Ridgefield Park, NJ 07660

1-800-223-0434 • 201-329-7300 • Fax: 201-329-7034