A large, semi-transparent watermark of the Eagle logo is centered on the page. It features a stylized eagle head in profile, facing right, with its wings spread. Below the eagle head, the word "Eagle" is written in a large, bold, red, cursive-style font with a blue outline. A small "TM" trademark symbol is located to the right of the eagle's head.

Case Study in Fermentation Performance between different ADY strains

A typical example of Data Analysis and Evaluation of
various dry yeast options in the ethanol industry

American Yeast Case Study

Performance Comparison of Eagle C6 FUEL and the Leading Competitor

Background

American Yeast (Eagle C6 FUEL) yeast seeks to serve the ethanol industry by introducing an alternative yeast to the ethanol market. We will do this by exceeding the minimum acceptable quality standards and providing the highest quality product at the lowest possible price. C6 FUEL is being introduced to offer an alternative to the current ADY products on the market. In order to establish trust and credibility, a series of plant trials were conducted to obtain real world data. This analysis is to establish the functionality of C6 FUEL against the industry standard.

Initial Trial Set Up

American Yeast conducted a performance comparison of the Eagle C6 FUEL dry yeast to that of the leading competitor (Competitor A) in a 50MMgal Ethanol facility in the Spring of 2010. The trial consisted of establishing a baseline of 20 production fermentations using Competitor A. This was followed by 20 production fermentations using Eagle C6 FUEL. In order to maintain an accurate comparison, no process or recipe changes were made during the trial. Due to the price advantage of C6 FUEL, the trial was to be considered successful if the fermentation performance matched or exceeded that of the incumbent dry yeast.

Results

Figure 1

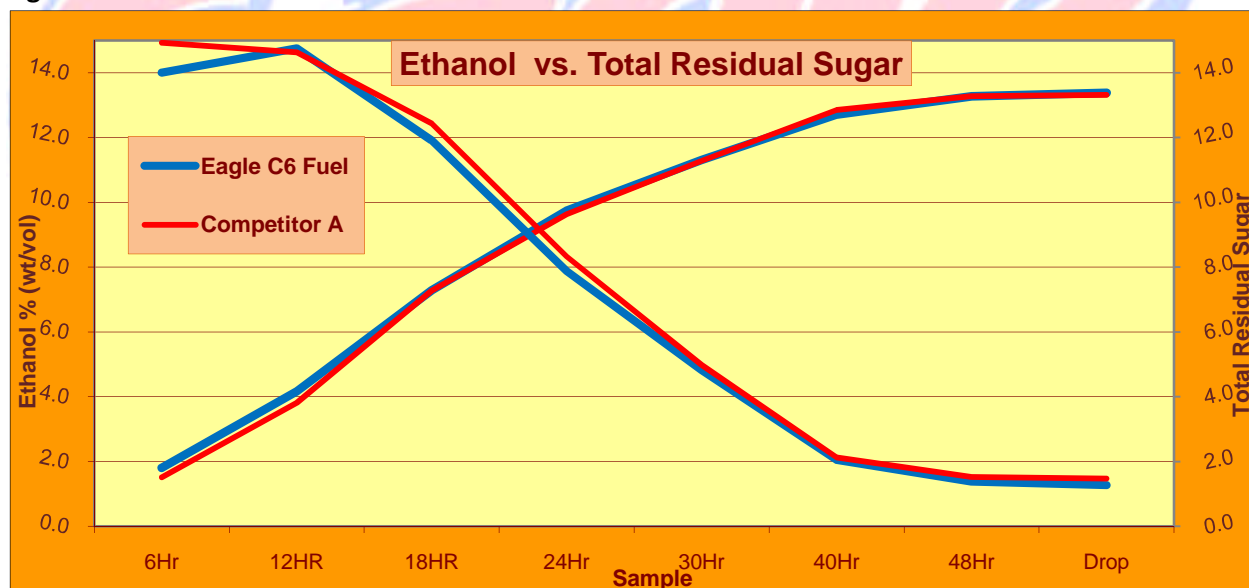


Table 1

Average Drop Results

	pH	Brix	Temp °F	DP4+	DP3	DP2	DP1	Lactic Acid	Glycerol	Acetic Acid	Ethanol	TRS
Eagle C6 Fuel	4.5	9.8	88.0	0.760	0.140	0.260	0.110	0.130	1.250	0.080	13.380	1.270
Competitor A	4.6	9.4	89.0	0.850	0.170	0.330	0.130	0.130	1.320	0.050	13.320	1.480

As illustrated in Figure 1 above, Eagle C6 FUEL on a cursory look shows very similar results to Competitor A over the course of fermentation. However upon further analysis, as shown in Table 1, Eagle C6 FUEL outperformed the competitor's yeast with a 0.06%w/v higher production of ethanol. The total residual sugar results decreased by 0.210% and we saw a reduction in glycerol of 0.070%. The glucose at the end of fermentation was lower by 0.020%. The increase in alcohol is likely due to the combined reduction in glucose and glycerol. These results were averaged over the course of the 20 fermentors operating at basically the same conditions throughout the trial. This trial length gives us good representative fermentation results while accounting for various plant operating and recycle effects to take place.

Benefit Analysis

A 0.060%w/v increase in ethanol generation per fermentor in a 50MMgal facility processing 550 fermentors in a production year would result in a gain of 269,000 gallons of additional alcohol per annum. At \$1.75 per gallon, this would result in a financial gain of \$470,750. This same increase in a 100MMgal facility processing 900 fermentors in a production year, would result in an annual revenue increase of \$847,000.

In addition to the easily quantified financial gain, there are other benefits to more efficient fermentation. These include the following:

- Higher ethanol generation in fermentation also increases energy efficiency in distillation.
- The lower residual sugar at drop decreases the risk for potential fouling in beer exchangers and evaporators which can lead to less efficient heat transfer, higher energy costs, and non-scheduled maintenance costs.
- Lower residual sugar can also contribute to added value in dried co-products as well.

Other Data Analysis – Advantages of using C6 FUEL

Table 2

Eagle C6 FUEL performs well in high solids fermentation. The following data sheet illustrates fermentation efficiency at 35% solids.

Sample	pH	Brix	Temp °F	Budding Cells	Cell Count	Dead cells	DP4+	DP3	DP2	DP1	Lactic Acid	Glycerol	Acetic Acid	Ethanol w/v
6Hr	5.4	26.0	92.0	33	188	10	6.93	0.63	4.55	7.33	0.06	0.44	0.07	1.85
12HR	4.9	19.4	91.0	96	194	9	6.47	0.72	4.13	6.21	0.08	0.72	0.04	4.37
18HR	4.8	18.0	90.0	68	272	12	4.82	0.52	2.58	5.71	0.11	1.03	0.03	7.55
24Hr	4.7	15.0	90.0	70	357	10	2.82	0.39	0.55	4.17	0.11	1.19	0.04	10.15
30Hr	4.7	15.0	90.0				2.79	0.41	0.62	3.97	0.12	1.21	0.04	11.35
40Hr	4.8	13.0	88.0				1.49	0.19	0.34	2.49	0.14	1.31	0.06	13.64
48Hr	4.7	11.0	89.0				0.93	0.17	0.32	0.60	0.14	1.36	0.07	14.95
Drop (54hrs)	4.7	10.0	88.0				0.84	0.16	0.33	0.08	0.14	1.35	0.07	14.91

As seen in Table 2, C6 FUEL maintains low glycerol numbers under the stress load of higher solids. Less glycerol production results in higher alcohol production, giving you the highest yield for your input.

Table 3

Eagle C6 FUEL will finish quickly to provide higher throughput. The following data sheet shows a strong 48hr finish.

Sample	pH	Brix	Temp °F	Budding Cells	Cell Count	Dead cells	DP4+	DP3	DP2	DP1	Lactic Acid	Glycerol	Acetic Acid	Ethanol w/v
6Hr	5.2	25.0	92.0	87	146	14	6.72	0.73	4.16	3.78	0.09	0.47	0.06	2.31
12HR	4.6	22.0	92.0	112	281	17	6.58	0.84	3.98	5.31	0.11	0.74	0.04	4.74
18HR	4.5	20.0	92.0	98	346	14	3.27	0.48	2.11	4.14	0.14	1.06	0.03	8.38
24Hr	4.5	18.0	92.0	106	463	15	2.39	0.86	3.44	7.08	0.15	7.08	0.04	10.41
30Hr	4.5	15.0	88.0				1.40	0.31	0.40	2.59	0.15	1.25	0.05	11.93
40Hr	4.5	12.2	88.0				0.81	0.18	0.33	0.78	0.16	1.28	0.07	13.45
Drop (48hrs)	4.5	10.0	88.0				0.70	0.18	0.31	0.14	0.16	1.30	0.07	14.05

As seen in Table 3, C6 FUEL will finish fermentation quickly. This increase in fermentation rate will allow you to process more fermentors over time to achieve maximum throughput.

Table 4

Eagle C6 FUEL has the endurance to last throughout fermentation. Here is an example of our yeast working to the end of 60+hours.

Sample	pH	Brix	Temp °F	Budding Cells	Cell Count	Dead cells	DP4+	DP3	DP2	DP1	Lactic Acid	Glycerol	Acetic Acid	Ethanol w/v
6Hr	5.2	25.0	90.0	68.0	129	14.0	5.21	0.39	3.40	5.80	0.10	0.78	0.07	2.12
12HR	4.9	19.4	90.5	96.0	194	9.0	6.47	0.72	4.13	6.21	0.08	0.72	0.04	4.37
18HR	4.8	18.0	90.0	68.0	272	12.0	4.82	0.52	2.58	4.71	0.11	1.03	0.03	7.55
24Hr	4.7	15.0	90.0	70.0	357	10.0	2.82	0.39	0.55	4.17	0.11	1.19	0.04	10.15
30Hr	4.6	13.0	90.0				1.69	0.26	0.36	3.08	0.12	1.25	0.06	11.69
40Hr	4.8	11.0	88.0				0.89	0.18	0.33	1.18	0.13	1.18	0.07	13.41
48Hr	4.8	10.0	89.0				0.77	0.17	0.32	0.11	0.11	1.34	0.07	14.18
Drop (65hrs)	4.9	9.8	90.0				0.72	0.16	0.32	0.04	0.12	1.34	0.07	14.37

As seen in Table 4, C6 FUEL continues to convert glucose well past the 60 hour mark. This is important in that the yeast are still viable at the end of fermentation and gives the plant a cushion if there are any plant upsets. This viability provides the opportunity to efficiently optimize enzyme additions as well as maximize yield.

Conclusions

1. C6 FUEL in plant operations successfully competed with the leading dry yeast competitor and in most cases outperformed it.
2. C6 FUEL works well in high gravity fermentations. This can facilitate increased solids per fermentor increasing ethanol output.
3. C6 FUEL can increase fermentation rate which will allow increased throughput which adds dollars to the bottom line.
4. C6 FUEL lasts longer throughout fermentation. This can lead to more glucose conversion directly resulting in higher ethanol values and increased yield.