



# Industrial Wastewater Pretreatment Challenges at a Beef Processing Facility

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**JBS Green Bay, Inc.**

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# JBS Green Bay Operations

- ▶ Formerly Packerland Packing, Inc.
- ▶ Company Founded in the 1960's.
- ▶ Four Packerland beef processing plants merged with four Swift, USA beef plants in 2008 to become JBS USA.
- ▶ JBS is collectively the largest meat/protein processor in the world.
- ▶ JBS Green Bay employs 1300 people.
- ▶ JBS Green Bay generates 1 MG + production wastewater per production day.

# JBS Green Bay Operations

- ▶ Processes 2100 + head of cattle per day.
- ▶ Processed 625,951 total head of cattle in 2009.
- ▶ Generated 335,735,000 million gallons of process wastewater in 2009.
- ▶ Generated 80,700 MCF of CH<sub>4</sub> in 2009 from anaerobic system to utilize in dedicated boiler for steam production—Significant Natural Gas cost avoidance.
- ▶ Earned Wisconsin Governor's Award in 2005: "Excellence in Environmental Performance-Biogas Beneficial Reuse".
- ▶ ISO 14001-Environmental Management System certified facility.

# JBS Green Bay Anaerobic Contact Pretreatment System



# JBS Green Bay Anaerobic Contact Pretreatment System

- ▶ In 1984, in order to reduce operating costs, Packerland Packing made plans to install a mesophilic anaerobic contact system.
- ▶ Construction began in 1985 and was completed in 1986.
- ▶ The system was designed to treat the following influent characteristics:
  - COD: 7500 mg/l
  - BOD: 3370 mg/l
  - TSS: 2700 mg/l
  - Design Average Daily Flow: .805 MG
  - Design Maximum Daily Flow: .910 MG

# JBS Green Bay Anaerobic Contact Pretreatment System

## ▶ Additional Wastewater Characteristics:

- **Organic Fraction** ▶ high levels of dissolved and suspended solids from carbohydrates, fats and proteins.
- **Inorganic Fraction** ▶ suspended particles such as sand, salts and cleaners.
- **Sanitizers** ▶ cleaners such as “Quat” (*Quaternary Ammonium compounds*) and Sodium Hypochlorite.

# JBS Green Bay Anaerobic Contact Pretreatment System

- ▶ The system was designed to achieve the following removal efficiencies:

COD: 84%

BOD<sub>5</sub>: 93%

TSS: 75%

# JBS Green Bay Anaerobic Contact Pretreatment System

- ▶ The final pretreatment plant design characteristics resulted in the following installations:
  - Pretreatment/DAF/Skimmer: **.030 MG** capacity.
  - Influent Chamber: **.028 MG** capacity.
  - Equalization Tank: **.280 MG** capacity.
  - Anaerobic Contact Tank: **2.3 MG** capacity.
  - Secondary Clarifier: **75' Diameter** - **.280 MG** capacity.

# JBS Green Bay Anaerobic Contact Pretreatment System



Anaerobic Contact Tank

# JBS Green Bay Anaerobic Contact Pretreatment System



Equalization Tank



Clarifier

# Digester Process Control

- ▶ **pH and alkalinity**: Low pH's will inhibit or "kill" methanogen activity. The JBS-GB anaerobic contact system pH must be maintained between **6.7 and 7.2** . JBS-GB system currently uses Magnesium Hydroxide on an as-needed basis.
- ▶ **Temperature**: The JBS-GB system operates best at a temperature of 36° C (**97° F**). Temperature is maintained utilizing a heat exchanger system augmented by steam from biogas boiler.

# Digester Process Control

- ▶ **Nutrient Requirements**: Micronutrient metals are required to maintain a healthy digester. JBS-GB metals micronutrient requirements are met through the use of  $\text{Cl}_3\text{Fe}$  (*Ferric Chloride*) as a coagulant. Micronutrients include, but are not limited to: Iron, Cobalt, Nickel and Zinc. Nitrogen and Phosphorus are essential macronutrients..
- ▶ **Solids Management**: Determine removal and disposal of settled clarifier biomass solids (**WAS**) by monitoring MCRT and sludge blanket depth. Floc characteristics and clarifier gasification influence this process.

# Digester Process Control Testing

- ▶ **JBS Green Bay currently performs frequent tests on the following parameters:**
  - COD (soluble and total); **TSS**; VSS; **MLSS**, MLVSS; **VFA**; VA; **Alkalinity**; Bicarbonate Alkalinity; **VA-Alkalinity Ratio**; pH; **Temperature**; Settleable Matter; **Sludge Volume Index**; Sludge Blanket; **MCRT**; Hydraulic Retention Time; **Solids Retention Time**; F/M Ratio; **Organic Loading**, COD kg/m<sup>3</sup>/day; **TSS** kg/m<sup>3</sup>/day; Flow Rate; **Feed Rate**; ORP; **Quat**; CH<sub>4</sub> Volume; **CH<sub>4</sub> Quality**; CH<sub>4</sub> BTU Value.

# Operating History

- ▶ For purpose of the forthcoming discussion we will look at monthly pretreatment performance averages beginning in 2004 (*results in mg/l and MG*).

## 2004-2007 Annual Averages

	TSS	BOD	TP	TKN	Flow Volume
2004	817	467	10	209	26.03
2005	419	252	9	218	24.14
2006	378	215	7	200	28.83
2007	452	309	8	206	28.65

# Then Something Happened...

## 2007- 2009 Annual Averages

	TSS	BOD	TP	TKN	Flow Volume
<b>2007</b>	452	309	8	206	28.65
<b>2008</b>	720	792	32	273	26.73
<b>2009</b>	1180	1794	36	292	27.98

# Early April, 2009...

pH	Temp.	Port # 4 COD
6.87	91.4	393
6.74	91.9	418
6.71	92.7	670
6.70	93.8	786
6.65	94.5	759
6.87	92.8	843
6.88	93.1	1820
6.89	93.4	1097
6.78	93.6	1320
6.78	94.5	1410

# Can You Guess What Happened Next?



# Digester Upset Conditions...



# Effluent Discharge Late April 2009

TSS	BOD	TP	TKN
138	711	37	225
138	825	33	302
105	1142	33	275
157	1359	34	294
56	1309	36	282
462	1536	41	299
1808	2343	27	186
4343	4763	65	506
7270	6418	70	533
1578	2634	50	295
8133	12009	81	502

# *Les Misérables*

TSS Daily Average Jan. 1 - April 24: 666 mg/l

TSS Daily Average April 25 - May 10: **3017 mg/l**

lbs TSS Daily Average Jan. 1 - April 24: 4528 lbs/d

lbs TSS Daily Average April 25 - May 10: **13,175 lbs/d**

BOD Daily Average Jan. 1 - April 15: 797 mg/l

BOD Daily Average April 16 - May 5: **2960 mg/l**

lbs BOD Daily Average Jan. 1 - April 15: 5224 lbs/d

lbs BOD Daily Average April 16 - May 5: **18,924 lbs/d**

# Mitigation Attempts

- ▶ pH adjustment - alkalinity increase - "Buffering".
- ▶ Continuous removal of dead biomass and foam – many trucks - many trips!
- ▶ Attempts at reseeding.

*"Sludge in Clarifier very dense-Clarifier Sweep/Skimmer Arm bent in half."*

# Biomass in Digester – “Dead Bugs” ...

Digester MLSS (mg/l)
5726
7730
<b>11574</b>
<b>12076</b>
<b>14334</b>

# What Happened?

- ▶ Many phone calls – many specialists.
- ▶ Chemical vendor(s) – *not entirely subjective!*
- ▶ Evaluation of recent operating history.
- ▶ Evaluation of buffering agents.
- ▶ Evaluation of treatment chemicals by 3<sup>rd</sup> party (*digester is influenced by RAS*).
- ▶ Plant cleanup prior to 1<sup>st</sup> known change in a key performance indicator (*digester top sampling port COD*).

# What Happened?

- ▶ Plant spring cleanup included increased use of “Quat” or Quaternary Ammonium compounds and Sodium Hypochlorite (12.5%). *This was focused on during the initial root cause analysis.*
- ▶ More discussions with chemical vendors.
- ▶ ***“No way was it our product”***

# What Happened?

## *Remember 2008?*

2007- 2009 Annual Averages				
TSS	BOD	TP	TKN	Flow Volume
452	309	8	206	28.65
<b>720</b>	<b>792</b>	<b>32</b>	<b>273</b>	26.73
1180	1794	36	292	27.98

# Coagulant Change

- ▶ A decision was made in late 2007 to change from Ferric Chloride to an organic coagulant. Change implemented in early 2008.
- ▶ This decision was based primarily on decreasing the WAS volume.
- ▶ Shrinking land base and other local issues made land application of sludge more challenging.

# Coagulant Change - *Unintended Consequences*

- ▶ TP effluent discharge immediately increased.
- ▶ TKN effluent discharge immediately increased.
- ▶ Hydrogen Sulfide (H<sub>2</sub>S) present in system.
- ▶ Other key performance indicators gradually developed negative trends - *these trends were somewhat subtle and accepted as a trade off for less sludge.*

# Coagulant Change - *Unintended Consequences*

- ▶ Key micronutrients were taken away when coagulant was changed. This was substantiated later by improved performance when key micronutrients in product form were added.
- ▶ Decision was made to return to the use of Ferric Chloride - Fall 2009.

# Improved Performance

## 2004 - 2010 (July) Annual Averages

	TSS	BOD	TP	TKN	Flow Volume
2004	817	467	10	209	26.03
2005	419	252	9	218	24.14
2006	378	215	7	200	28.83
2007	452	309	8	206	28.65
2008	720	792	32	273	26.73
2009	1180	1794	36	292	27.98
2010	270	329	15	229	32.09

# Improved Performance

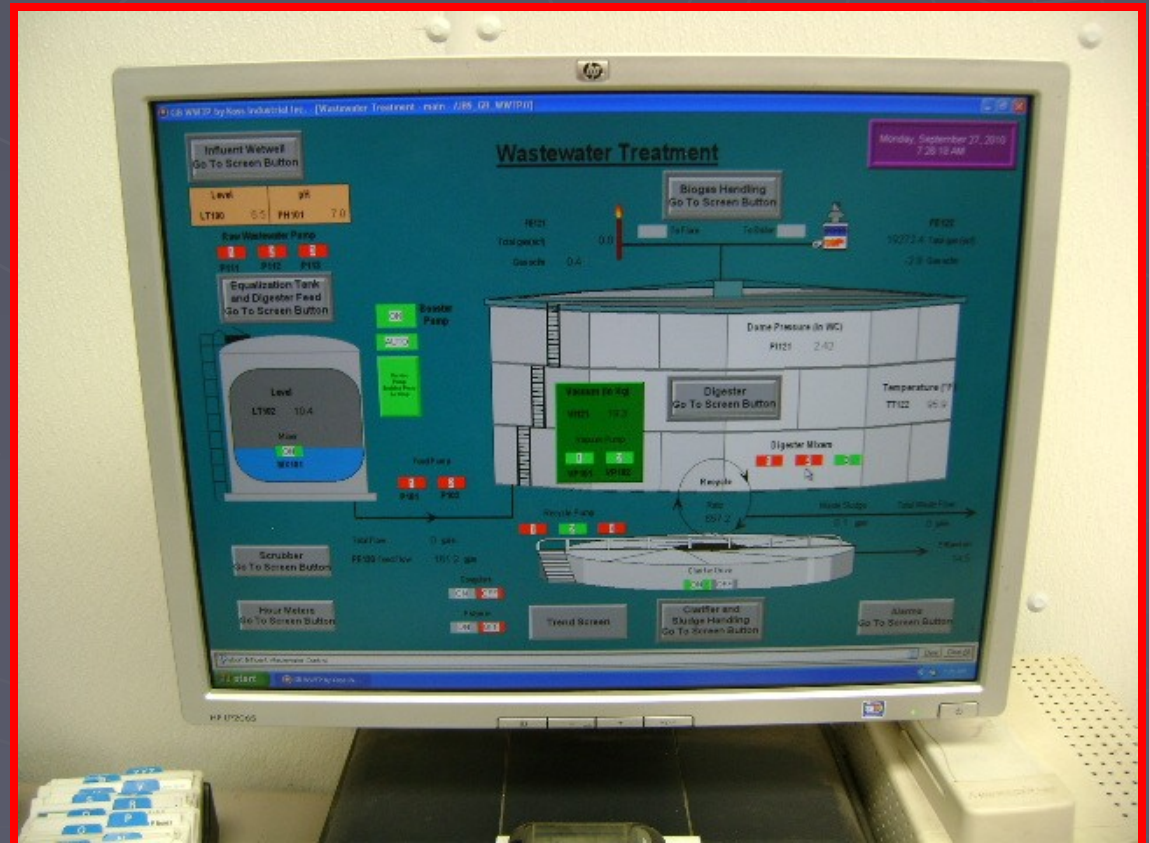
- ▶ Biogas production through July 2010: **93,388 MCF**. 2009 total= **80,700 MCF**.
- ▶ Effluent numbers more consistent.
- ▶ H<sub>2</sub>S episodes eliminated.
- ▶ Improved settleability.
- ▶ Increase in sludge production offset by improved performance (\$).

# Additional Improvements

- ▶ DAF sludge removed from WWTP influent more frequently - **FOG**.
- ▶ Influent ORP now monitored daily- Sodium Bisulfite added during midday plant cleanup or as needed. ORP target of **-200** maintained for optimum anaerobic conditions.
- ▶ Influent monitored daily for “Quat”.

# Additional Improvements

- ▶ WWTP Control Room upgrade.
- ▶ **SCADA** for all feed pumps, levels and alarms.



# Additional Decisions and Improvements

- ▶ RFP for WWTP upgrade evaluation issued in September 2009.
- ▶ Corporate decision to place upgrade evaluation on hold.
- ▶ Decision to install grease recovery equipment and additional DAF.
- ▶ Decision to upgrade digester mixing system.

# Additional Decisions and Improvements

- ▶ Bulk Ferric System installation (*was using IBCs*).
- ▶ Direct steam injection project submitted for approval - will maintain continuous and consistent temperature in digester.
- ▶ Removal of additional TSS and insoluble BODs from influent – plan to install additional solids removal unit on “green” water streams.

# Additional Decisions and Improvements

- ▶ Increased awareness and operator meetings.
- ▶ Continuous improvement using ISO 14001 EMS corrective action process.
- ▶ Increased operator training and education.

# ISO 14001 Environmental Management System

- ▶ International Standards.
- ▶ Maintained continuously and audited frequently.



# Operator Certifications

- ▶ Not required for “Pre-treatment Facility”.



# Industrial Discharge Permit

- ▶ Issued by GBMSD. Permit # 028-3.
- ▶ JBS Green Bay, Inc. is a high strength industrial user.
- ▶ Bi-annual Periodic Compliance Reports.
- ▶ Daily sampling for TSS, TKN, BOD and P.
- ▶ Weekly sampling for O&G.
- ▶ Annual inspections.
- ▶ Annual Inspection.
- ▶ Important to maintain good a relationship with GBMSD.

# Budget

- ▶ Annual Capital Budget based upon improvement recommendations factored into ROI. Regulatory issues considered.
- ▶ Annual operating budget based upon previous years total surcharges and operating costs + percentage anticipated increases. Anticipated production also factored into this budget.

# Projects



# Repair and Maintenance

- ▶ WWTP operators perform routine tasks.
- ▶ Plant Rendering Maintenance Department provides R&M functions.
- ▶ Select group of vendors for pumps and specialty items.
- ▶ Critical equipment list maintained.
- ▶ Scheduled routine maintenance tracked on company-wide system.

# Chemical Program

- ▶ Formal RFP issued (*for polymers only*).
- ▶ Vendors scheduled to allow product testing.
- ▶ Test results are evaluated.
- ▶ All intangibles considered.
- ▶ Value-added service preferred.
- ▶ JBS has a formal chemical approval program (*reviewed by environmental, safety, food safety and purchasing departments then forwarded for corporate approval in Colorado*).

# Biogas Program

- ▶ As previously mentioned-very **GREEN** process.
- ▶ 24.56 mmBtu/hr Cleaver Brooks boiler fired with methane from anaerobic digester.
- ▶ Biogas safety program.
- ▶ Gas conditioning considerations-little or no H<sub>2</sub>S.
- ▶ 95% of generated gas utilized-little “**flaring**”.
- ▶ Provides 20-25% of production plant demand for steam.
- ▶ Good Quality Biogas.
  - CH<sub>4</sub> in 70 – 77% range.
  - CO<sub>2</sub> in 23 – 26 % range.
  - Remaining small percentage of Nitrogen.

# Biogas Program



# Biogas Program



# Biogas Program



# Biosolids Management

- ▶ 7000-8000 wet tons of sludge generated from WAS process.
- ▶ Land application, composting and outside digester used for final disposition.
- ▶ Excellent fertilizer - application rate = 7.5 wet tons per acre-high TKN.
- ▶ WPDES permits limits land application to 165 lbs TKN per acre.

# Biosolids Management



# Biosolids Management

- ▶ No cumulative metals issues.
- ▶ No pathogen issues.
- ▶ 8000-9000 wet tons of “Paunch” generated per year – also under WPDES permit.
- ▶ Additional 9000-10,000 wet tons of barn waste per year – not part of permit.
- ▶ All biosolids tracked and managed by Environmental Department.
- ▶ JBS Green Bay involved in **Brown County Waste Transformation Initiative** to transform area animal waste and to reduce the impact of non-source point pollution and prevent well contamination.

# Biosolids Management



# Water Conservation Program.

- ▶ Water usage measured in Gallons Per Head.
- ▶ Measured throughout organization-Goals established.
- ▶ JBS Green Bay uses 460–500 Gallons Per Head.
- ▶ All areas of use metered-manual and electronic readings.
- ▶ Water use results emailed daily.
- ▶ Water Conservation Team-meetings on regular basis to review results and identify opportunities.
- ▶ Reduced usage reduces a number of costs.

# Stormwater Management

- ▶ WPDES General Permit.
- ▶ Inspections and reports from WW/Environmental Personnel.
- ▶ Include SPCC responsibilities.
- ▶ Trained in spill response and regulatory reporting.

# Facility Air Treatment

- ▶ WDNR Air Operating Permit.
- ▶ Rendering Scrubbers and Biofilter.
- ▶ Ozone Generator.
- ▶ Wastewater Scrubber.
- ▶ Permit Conditions.
- ▶ Maintenance and required inspections.
- ▶ Wastewater operators have responsibilities.

# Facility Air Treatment



# Facility Air Treatment



# Thank You!

