North America
SERVICE REGION

Oil & Gas
ERI PRODUCT DIVISION

When Pressure Becomes a Reliable Energy Source:

A white paper on how a South Texas gas plant saves energy using IsoBoost™ Energy Recovery System.

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EXECUTIVE SUMMARY

Pressure is a common byproduct of many oil and gas related operations and though it has the ability to reliably drive a wide range of processes; it's largely been disregarded as a potential source of energy. This, however, is quickly changing as producers look for new and efficient ways to cut carbon emissions and overcome the challenges associated with increasing operating costs. One innovation that has proven to be effective in accomplishing these goals is Energy Recovery's IsoBoost Technology, which transforms unwanted pressure into a reliable source of clean, sustainable power. IsoBoost has been particularly effective at helping producers save energy and increase productivity in the natural gas sweetening process, where it can be used to recover and reuse a great deal of pressure energy that is is otherwise wasted. This white paper will provide a detailed explanation of how IsoBoost Technology works and how it can be used to turn pressure from a costly liability into an invaluable asset. It will also include a quantitative examination of the technology's performance at an amine gas processing plant in Hebbronville, TX. where an estimated $1Million in energy savings has been realized.

Last year, Energy Recovery saved their clients a total of $1.4 billion in energy costs.

INTRODUCTION

Natural gas is one of the fastest-growing fuel sources in the world, and due to its abundance, reliability, and clean-burning properties, its demand is expected to rise more than 60% by the year 2040[1]. Currently, 50% of the total cost associated with gas refinement operations is represented by energy consumption[2]. Midstream industrial processes in particular are very energy-intensive and as a result, there's significant opportunity to take advantage of hundreds of millions of dollars in savings by increasing efficiency. In many instances, this can be achieved by recovering energy that's already been introduced into the system. Recovered energy can generally come from any number of sources within the refinement process but one that it doesn't typically come from is the release of pressure.

Amine gas processing (or gas sweetening) is a treatment method in which the existence of large pressure differentials presents a unique opportunity to recover energy and produce substantial amounts of power. It's widely used for the removal of H_2S (hydrogen sulfide) and CO_2 (carbon dioxide) from raw natural gas by pumping lean amine into a highly pressurized contact vessel (up to 1200 psi) where it can react with an incoming product stream.

50% of the total cost of refining is represented by energy cost.

There are various types of amine used in both CO_2 and H_2S sweetening processes. Each has a different ability to absorb the target gases and as a result, the flow rates of the amine solutions are different. This difference has a significant influence on the electrical energy required to operate the amine sweetening system. Table 1 shows the types of amine solutions and their relative capability of gas absorption. The ability to load the amine determines the electrical energy necessary to raise the pressure to the required level for operation.

[1] Statoil - Energy Perspectives 2012 (June 2012). Long-term Macro and Market Outlook. Source: http://www.statoil.com/en/NewsAndMedia/News/2012/Downloads/Energy Perspectives 2012.pdf

[2] European Forum for Science and Industry. (2013, December 12). Retrieved From: https://www.europia.eu/content/default.asp?PageID=870

	Molecular Weight (lb/lbmole)	**Amine Strength** (Wt.-%)	**Rich Loading** (mol/mol)	**Acid Gas Capacity** (lbmol/t)
MEA	61	15-20	0.35	2.53
AEE (DGA®)	105	30-60	0.35	3.68
DEA	105	25-35	0.4	2.52
DIPA	133	20-40	0.45	3.35
MDEA	119	35-50	0.45	4.16

Table 1 — Typical Amine Strength & Acid Gas Loading of Amines

After the amine becomes saturated it exits the contact vessel and flows into a regenerator where it can be stripped of impurities and reused. Because the internal pressure of the regenerator is usually close to that of the outside atmosphere, the rich amine must be depressurized after it leaves the contactor and during this process, energy is dissipated. It is at this point in the gas sweetening process where recovery opportunities are greatest. A flow diagram of a typical amine treatment operation can be seen below in Figure 1.

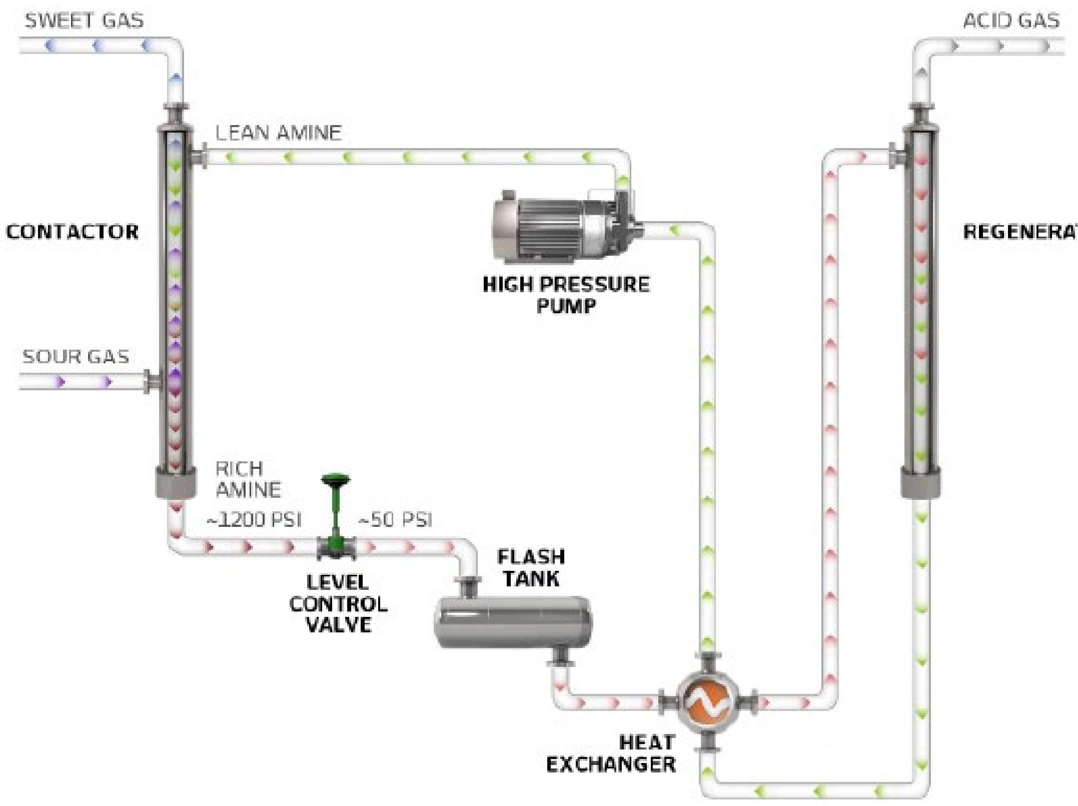


Figure 1 — Flow Diagram of Typical Amine Treatment Process (without Energy Recovery)

Without a recovery system in place, the energy from depressurization as the amine passes through a pressure-reducing level control valve (LCV) is lost and unrecoverable. However, with Energy Recovery's IsoBoost Technology, this energy can be harvested and injected back into the treatment system where it can be used to re-pressurize the lean amine. **This results in an overall boost in system efficiency by decreasing energy consumption, reducing carbon emissions and minimizing operating expenditures.**

The remainder of this paper will focus largely on IsoBoost Technology and how it can be used to transform energy derived from pressure into measurable economic value. It will include a detailed technical description of an IsoBoost System along with an examination of its performance at the Jackalope Amine Gas Processing Plant in Hebbronville, Texas, where its implementation has resulted in a reduction in carbon emissions and energy savings of over **$150,000** per year.

OVERVIEW OF **ISOBOOST TECHNOLOGY**

Energy Recovery's IsoBoost Technology is made possible by a precision-manufactured pressure exchange system that's specifically designed to capture and reuse energy that would otherwise be dissipated during the depressurization of rich amine in the sweetening process.

At the heart of the system is the GP Turbo, a liquid phase turbocharger (Figure 2), which consists of a high-efficiency turbine powering a centrifugal pump. During the sweetening process, highly pressurized rich amine from the contactor is directed into the turbine side of turbocharger inlet. It is here that pressure that would normally be wasted is captured and converted into hydraulic energy.

After depressurization, the rich amine then leaves the turbine and flows into a flash tank on its way to the regenerator circuit. A flow diagram showing the sweetening process fully integrated with IsoBoost Technology along with a model design of the system can be seen in Figure 3 below.

Figure 2 — Liquid Phase Turbocharger

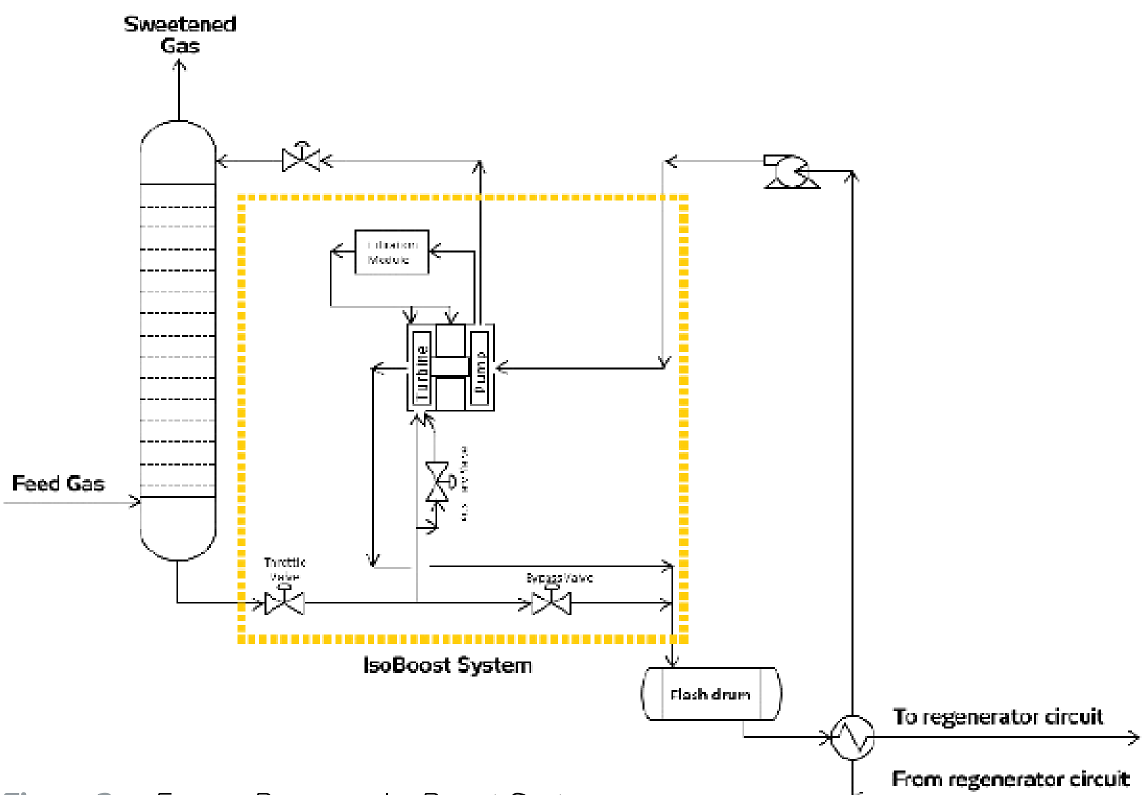


Figure 3 — Energy Recovery IsoBoost System Flow Diagram and Model Design

After lean amine leaves the regenerator circuit, it is partially pressurized by a circulation pump and then directed back into the IsoBoost System where it enters the pump side of turbocharger. The hydraulic energy absorbed by the turbine from the rich amine leaving the contactor is then used to further increase the pressure of the lean amine so that it can be re-injected back into the contactor vessel.

The IsoBoost Pressure Exchange System is designed with 3D geometry impellers and is capable of sustaining up to 80% energy efficiency[3]. Equipped with throttle, bypass and auxiliary valves, it is capable of controlling the fluid level in the contactor to the desired set point. Typically, the circulation pump used with the IsoBoost System in Figure 3 would be roughly one-third the size of the high-pressure circulation pump that's needed to operate a typical amine treatment system (like the one seen in Figure 1).

Based on energy savings alone, the equipment related return-on-investment period (payback period) for IsoBoost Technology in average-sized processing plants is ***typically less than three years***. Actual ROI is, of course, highly dependent on plant specifics and in many large-scale operations with high differential pressures and large flow capacities the payback period can be even shorter.

[3]Energy Recovery (July 2013). Energy Recovery in Amine Gas Processing Using a Liquid Phase Turbocharger.

"The IsoBoost does not affect plant availability. If anything, it runs better. You are not using the big engines, or putting so much strain on electrical equipment. We are saving electricity and emission compliance by not using gas engines. Roughly we save 50% of the energy with the turbocharger."

- Odell Gonzalez
Plant Manager

Jackalope Amine Gas Processing Plant,
Hebronnville, Texas

ENERGY SAVINGS
FROM ISOBOOST AT JACKALOPE

In December of 2008, Energy Transfer -- a master limited partnership that owns and operates a diverse portfolio of energy assets throughout the United States -- was faced with a dilemma at their Jackalope Amine Gas Processing Plant in Hebbronville, TX. The plant, which was commissioned in 1997, has an amine flow rate capacity of 750 GPM and produces approximately 50 million cubic feet of natural gas per day.

Until 2008, Jackalope had been using gas-fired plunger pumps to inject pressurized amine into their contactor vessel, but with tightening environmental regulations in the state of Texas and carbon emission rates already at their limits, the pumps needed to be decommissioned and replaced with a more energy efficient option.

When searching for a replacement, Energy Transfer explored a number of options, including replacing the gas-fired equipment with electrical pumps. Their goal was not only to reduce carbon emissions below the admissible levels for the state of Texas, but also to find a long-term, economically viable solution that could significantly cut energy costs over the remaining lifespan of the plant. Eventually, the option of turbochargers was explored and the decision was made to partner with Energy Recovery to implement an IsoBoost Recovery System using Energy Recovery's proprietary GP turbo technology. Best Pumpworks deployed this system using a Wood Group Booster pump. A summary of the system design parameters at Jackalope along with subsequent savings from the implementation of the IsoBoost Technology are displayed in Table 2 at left.

Lean Amine Flow (gpm)	681
Rich Amine Flow (gpm)	681
Pump In Pressure (psi)	44
Pump Discharge Pressure (psi)	800
Turbine In Pressure (psi)	760
Turbine Discharge Pressure (psi)	112
Bypass (gpm)	7
Turbo Efficiency (%)	65
Auxiliary Valve Position	Closed
Turbo Pressure Boost (psi)	421
Require HPP Discharge Pressure (psi)	379
New Pump Efficiency (%)	75
New Pump Flow (gpm)	681
Pump Shaft Power (kW)	132
Motor & VFD Efficiency (estimated %)	94
Total Power Consumption (kW)	141
Original HPP Discharge Pressure (psi)	800
Original Pump Flow (gpm)	681
Original Pump Efficiency (%)	75
Original Pump Shaft Power (kW)	298
Motor & VFD Efficiency (estimated %)	94
Total Original Consumption Power (kW)	318
Power Savings (kW)	177
Annual Energy Savings (MWh)	1,550
Annual Energy Savings ($)	155,000
Total Energy Savings Since Installation ($)	**930,000**

Table 2 — Design Parameters and Energy Savings at Jackalope

Since its installation six years ago, the IsoBoost system has saved Energy Transfer an average of 1,550,000 kWh per year. This equates into an annual sum of $155,000 (assuming $0.10 /kWh) and a total reduction in approximately 14.4 million pounds of CO2 equivalent[4].

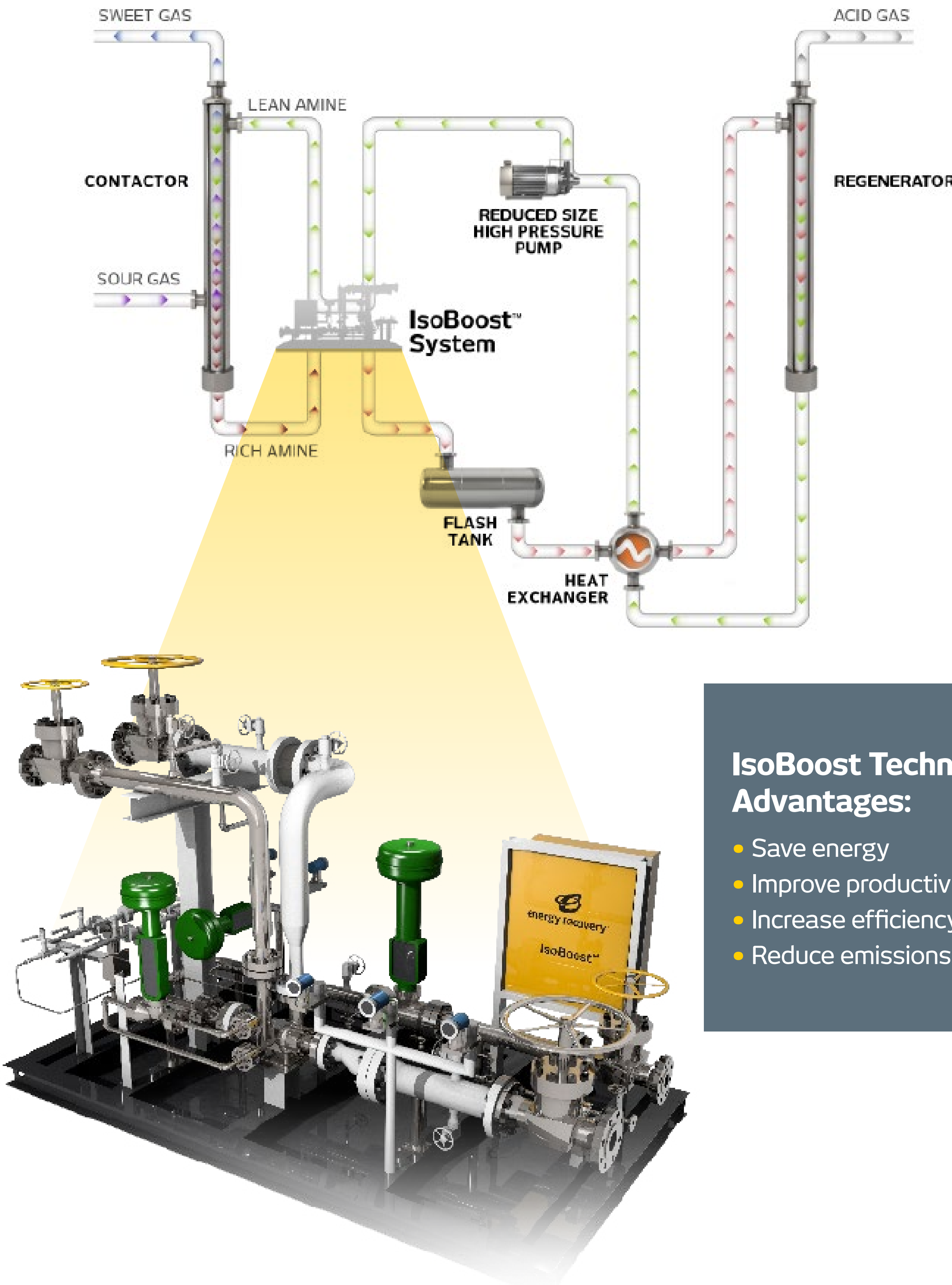
A significant portion of this savings can be attributed to IsoBoost's ability to effectively recover and reuse pressure energy, as well as to its superior reliability. In six years of operation, the system has required virtually no maintenance and has been running for six consecutive years, resulting in maximized throughput[5]. An image of the IsoBoost system at Jackalope can be seen in Figure 4 below.

In six years of operation, the IsoBoost technology has:

- run continuously
- required no maintenance
- saved plant owners almost $1M in energy savings
- reduced emissions by a total of 14.4 million pounds of CO_2 equivalent

Figure 4 – Skid-Mounted IsoBoost Pressure Exchange System at Jackalope Processing Plant

Figure 5 — Flow Diagram of Typical Amine Treatment Process with IsoBoost™ System



IsoBoost Technology Advantages:

- Save energy
- Improve productivity
- Increase efficiency
- Reduce emissions

SUMMARY

Today's economic climate leaves no room for lost profits, an evolution that is leading to a rapidly changing mindset across the oil and gas sector. Energy is a major cost of processing, and generating greater energy efficiencies leads to a substantial operational cost reduction. The oil and gas industry is the world's principal generator of energy and continues to look for ways to recover energy used in the process as a means to become more efficient, productive, and profitable.

The natural gas sweetening process has significant opportunity for savings, particularly during the depressurization of rich amine, a point in the cycle where large amounts of energy are dissipated. Globally, there are over 1200 gas processing plants with flow rate capacities up to 10000 GPM, representing untapped potential to harness wasted energy into reusable productivity within the process cycle. Energy Recovery's proven technology can save plants hundreds of millions of dollars in energy savings, as demonstrated in the results at a Texas plant.

[4] Environmental Protection Agency. (12 December 2013). Greenhouse Gas Equivalency Calculator. Retrieved from: http://www.epa.gov/cleanenergy/energy-resources/calculator.html

[5,6] Energy Recovery Proprietary Data (2014)

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For the latest information about our product and services, please visit our website at **www.energyrecovery.com** or our Oil & Gas Blog at **blog.energyrecovery.com/category/oil-gas.**

References:

Statoil (June 2012). Energy Perspectives 2012. Long-Term Macro and Market Outlook. 5 June 2012.

European Forum for Science and Industry. Scientific Support to EU Refining Capacity. (October 2012).

Krish P. (July 2013). Energy Recovery in Amine Gas Processing Using a Liquid Phase Turbocharger. White Paper.

Environmental Protection Agency. Greenhouse Gas Equivalency Calculator. (12 December 2013).

Nawaz I. Burch B. Weidmann M. Energy Recovery from Amine H2S Separation Process Streams Using a Hydraulic Turbocharger Recovery Unit. White Paper.