



Identification and Quantification of Emissions Reduction Opportunities at Oil & Natural Gas Facilities

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Topics

- **Challenges and Opportunities**
- **Study Approach**
- **Study Cases**
 - **Natural Gas Processing Plant**
 - **Oil Production Facilities**
- **Conclusions and Recommendations**





Challenges and Opportunities

- **Energy Conservation and Emission Reduction Goals During the 11th Five-year Plan in China**
 - **Energy intensities reduced by 20%**
 - **Key environmental emissions reduced by 10%**
- **CNPC's Environmental Commitments & Achievements**
 - **The Baseline Years for Safety & Environment Tracking**
 - **Safety & Environmental Contracts with Subsidiary Companies**
 - **HSE Management System**
 - **2006 Social Responsibility Report**
 - **Safety & Environmental Technology Institute**



Study Approach

- **Research Method**
 - **Identification and quantification of cost-effective emission reduction opportunities**
 - **Impact Assessment and Forecast**
 - **Evaluation and Selection of Control Technologies**
- **Applied Detection & Quantification Technologies**
 - **Infrared Camera**
 - **HiFlowTM Sampler**
 - **Combustion Analyzer**
 - **Velocity Probes**
 - **Vapor Analyzers**
 - **Analysis Software**





Case I: Gas Processing Plant

■ Site Surveys

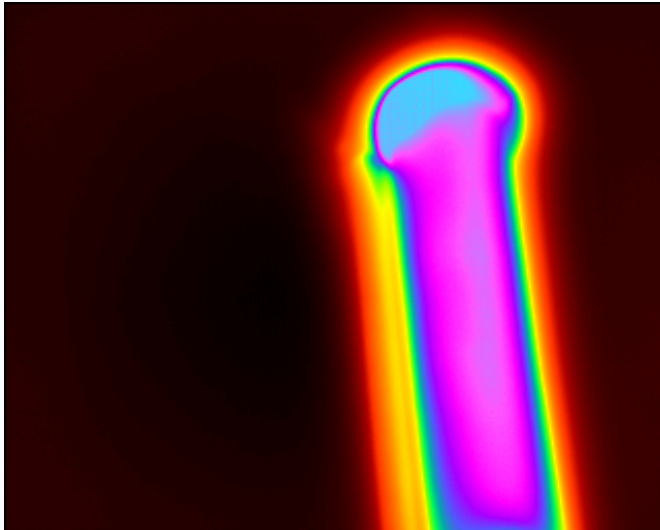
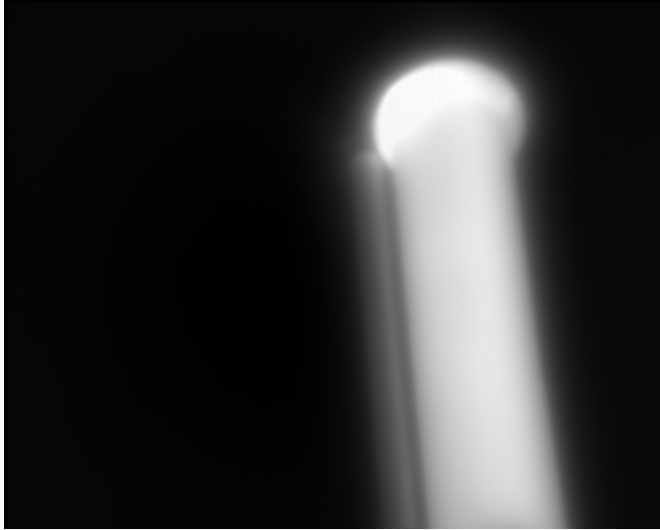
- Equipment Leaks
- Boilers/Heaters
- Glycol Dehydrators
- Emergency Flare

■ Measurement & Analysis Method

- Leak detection (IR Camera)
- Thermal efficiency of natural gas fueled equipment (Portable combustion analyzer and diagnostics software)
- Glycol dehydrators (Process simulator)
- Residual gas flows to emergency flares (API RP 521 – flame size correlation)



Dehydrator Vents





Dehydrator

Dehydrator No.	Value of Vented Gas (\$/y)	Value of Avoidable Fuel Gas Consumption (\$/y)	Potential Reduction of Emissions (fuel consumption & vents)					
			CH ₄		VOC		GHG	
			(t/y)	(%)	(t/y)	(%)	(t/y)	(%)
1	11,400	15,000	3.6	20	1.2	20	282	18
2	11,400	15,000	3.5	20	1.0	21	281	18
3	11,400	15,000	4.1	20	2.4	19	291	18
5	11,400	15,000	3.9	20	2.0	19	288	18
6	4,920	7,500	1.9	9	0.5	9	144	7



Combustion Measurement on Heaters and Boilers





Combustion Equipment

No.	Type of Facility	Measured Efficiency (%)	Emissions		Reduction Potential (\$/y)		
			CH ₄ (t/y)	GHG (t/y)	A/F Ratio Adjustments	Heat Transfer Improvements	Waste Heat Recovery
1	Reboiler	59.8	0.2	583.9	3,713	8,603	8,006
2	Reboiler	63.8	0	580.3	2,252	6,869	6,838
3	Reboiler	35.2	1.6	609.0	11,636	19,310	16,173
4	Reboiler	58.6	1.2	601.3	4,082	9,109	8,285
5	Reboiler	54.5	0	994.2	8,043	18,590	17,006
6	Boiler	74.8	0	4,398.8	6,554	16,789	20,339
7	Boiler	75.6	0	5,510.6	4,966	17,754	23,602
8	Boiler	77.4	0	8,451.2	206	16,045	30,074
9	Boiler	77	0	9,072.3	2,046	19,891	34,238
10	Boiler	72.3	0	1,258.8	836	7,278	7,538



Emergency Flare





Emergency Flare

Type of Facility	Flare No.	Flare Rate (m ³ /h)	Value (\$/y)	Emissions		
				CH ₄ (t/y)	CO ₂ (t/y)	GHG (t/y)
Gas Plant (Trains #1-5)	1	653	783,671	73.5	10,433	11,977
Gas Plant (Train #6)	2	974	1,169,151	109.7	15,565	17,869



Brief Summary

- **Modern well-built facility and very well-maintained**
- **Minimal performance monitoring on combustion equipment**
- **Leakage and excessive purge gas flows into the flare difficult to detect**
- **Current focus more on losses to atmosphere than losses to flare system**



Case II: Oil Production Facilities

■ Site Surveys

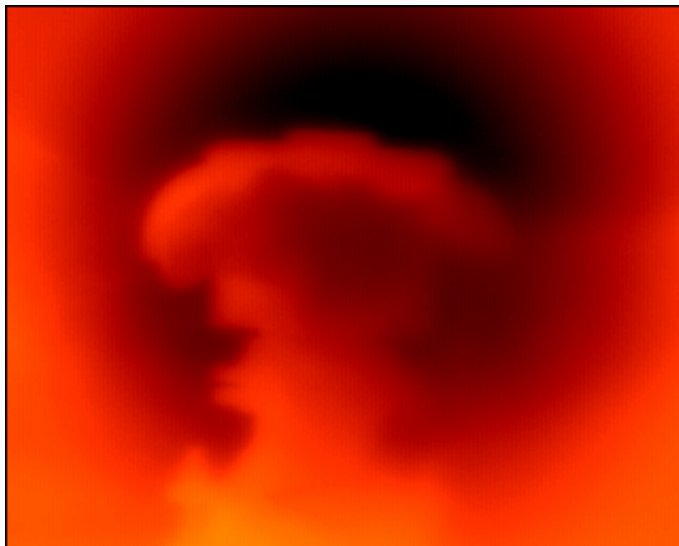
- Oil treating facilities, oil batteries, oil well production pads
- Associated gas, flare/vent, boilers, tanks

■ Measurement & Analysis Method

- Leak detection and quantification (IR Camera and HiFlowTM Sampler).
- Flare/vent gas flows (micro-tip vane anemometer and API RP 521 – flame size correlation)
- Detect and quantify flashing losses and gas carry-through to storage tanks (micro-tip vane anemometer)
- Thermal efficiency of natural gas fueled equipment (portable combustion analyzer and diagnostics software)



Tank Vents





Tank Fittings



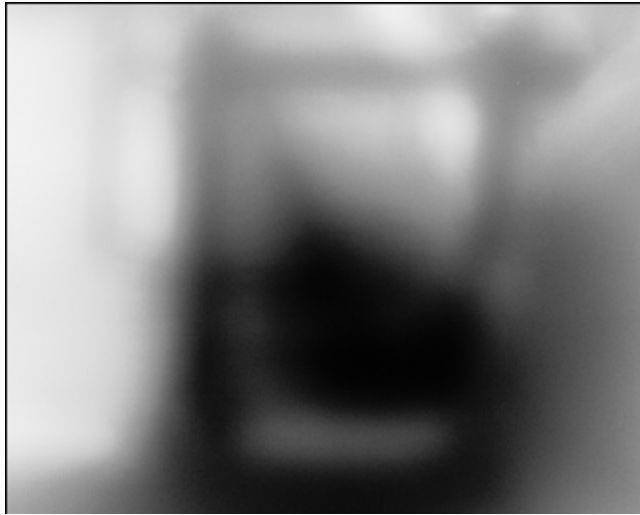


Storage Losses

Site	Type of Facility	Tank No.	Vent Rate (m ³ /h)	Value (\$/y)	Emissions		
					CH ₄ (t/y)	VOC (t/y)	GHG (t/y)
2	Oil Battery & Well Pad	1	2.6	3,106	15	0.9	308
3	Oil Battery	2	204.8	245,748	1,153	70.3	24,339
		4	245.7	294,854	1,383	84.3	29,202
		7	317.1	380,504	1,785	108.8	37,685
8	Oil Battery & Well Pad	3	30.9	37,068	174	10.6	3,671
		4	58.7	70,397	330	20.1	6,972



Casing Gas Vents/Flaring





Casing Gas Measurement





Casing Gas

Site	Type of Facility	Vent No.	Measured Vent Rate (m ³ /h)	Disposition	Value (\$/y)	Emissions		
						CH ₄ (t/y)	CO ₂ (t/y)	GHG (t/y)
2	Oil Battery & Well Pad	1	288.0	Flared	345,559	32.4	4,601	5281
5	Oil Well Pad #1 (South Pad)	1	104.4	Flared	125,313	11.8	1,668	1915
5	Oil Well Pad #1 (North Pad)	2	415.6	Flared	498,722	46.8	6,640	7622
6	Oil Well Pad #2	1	147.5	Flared	176,984	16.6	2,356	2705
7	Oil Well Pad	1	9.2	Vented	11,012	51.7	5.81	1091
8	Oil Battery and Well Pad	1	24.8	Flared	29,746	2.8	396	455
9	Oil Well Pad #1	1	20.5	Flared	24,578	2.3	327	376
10	Oil Well Pad #2	1	56.6	Flared	67,973	6.4	905	1039



Gas Fuelled Power Generator





Combustion Test: Heaters & Boilers





Combustion Equipments

No.	Type of Facility	Measured Efficiency (%)	Emissions		Reduction Potential (\$/y)		
			CH ₄ (t/y)	GHG (t/y)	A/F Ratio Adjustments	Heat Transfer Improvements	Waste Heat Recovery
11	Heater	33.6	24.2	972.6	9,886	19,707	9,801
12	Heater	50.2	13.0	1,465.8	17,248	28,356	17,899
13	Heater	56.4	2.4	526.1	3,724	8,446	6,758
14	Heater	53.6	11.9	2,702.0	32,348	49,272	38,956



Brief Summary

- **Lack associated gas conservation or utilization**
- **Lack of formal program to monitor and manage the efficiencies of natural gas fuelled process equipment**
- **Lack of vapor recovery**
- **Purchasing of gas and electricity while venting/flaring associated gas at some sites**



Total Reduction Potential at Surveyed Facilities

Source Category	Value of Wasted Fuel or Gas (\$/y)	CH ₄ Emissions (t/y)	GHG Emissions (t/y)	Control Technology	Reduction Potential (%)
Fugitive Equipment Leaks	N/A	N/A	N/A	DI&M program	70 – 80
Emergency Flares	1,953,000	479	77,991	- Flare gas recovery system	90
				- Purge gas optimization & flare valve leak detection program	99
Heaters/Boilers	108,000 - 354,000	55	37,727	- A/F management	4
				- Replace with more efficient designs	18
Dehydrator Vents	287,000	91	1,907	Flare or vent condenser with methane utilization	95
Casing Gas Venting and Flaring	1,280,000	171	20,484	Waste gas utilization or recovery	95
Storage Losses	1,032,000	4,840	102,177	Vapour Recovery	95



CONCLUSIONS

- **An integrated survey of a gas processing plant and selected oil production facilities identified a number of significant cost-effective opportunities to reduce CH₄ and total GHG emissions.**
- **Implementing these opportunities would provide the following benefits:**
 - **Reduced GHG emissions**
 - **Resource conservation**
 - **Potentially increased production through reduced losses and fuel consumption**
 - Increased revenues
 - Reduced operating costs
 - **Generation of marketable carbon credits**
 - **Improved environmental performance:**
 - Associated reduction of other pollutants, e.g., H₂S, VOC, NO_x, SO₂
 - **Safer workplace**
 - **Best in class recognition**



RECOMMENDATIONS

■ Gas Plant

- **Install reliable auto-ignition system on flares and initiate a purge gas management program.**
- **Initiate a program to regularly tune all heaters and boilers and replace/repair any low efficiency units.**
- **Initiate a program to optimize glycol dehydrators and consider installing controls on the glycol dehydrator still-column vents.**

■ Oil Production Facilities

- **Install casing and associated gas recovery or utilization systems.**
- **Install vapor recovery at the large oil treating plants.**

■ General

- **Develop a ongoing and expanded program to optimize facilities and reduce atmospheric emissions.**



THANK YOU!

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