H_2S REMOVAL FROM GAS STREAMS THREE-PHASE FLOW (WATER+OIL+GAS)

BY ECOIL TECHNOLOGIES

PROBLEMS OF OIL AND GAS COMPANIES WITH TREATMENT OF GAS STREAMS FROM HYDROGEN SULFIDE AND MERCAPTANS.

“In the good old days,” natural gas production was a lot easier. Gas was relatively plentiful, easy to find, and sweet. Today, it is generally accepted that natural and petroleum gas production is becoming more sour. Gas sweetening technologies tend to be expensive, which can be especially troublesome for the small gas streams producers-operators. This focuses on the gas sweetening technologies at the “small capacity” end of the spectrum, and the issues involved in comparison with the selecting the right scavenger of your choice.

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WHICH SOLUTIONS?

In the world practice of gas production and processing (natural and associated petroleum gas), conditional boundaries have long been determined between the areas of applicability of various types of technologies for removing sulfur-containing compounds - hydrogen sulfide H_2S and mercaptans. For gas streams with a high sulfur content (in terms of sulfur extracted from the gas - from 15 tons per day and more), the most economically acceptable are absorption cleaning methods with the regeneration of the absorbent (usually amine) and the processing of the recovered hydrogen sulphide at Claus plants, or the purification of acidic regeneration gases by oxidation of hydrogen sulphide over heterogeneous catalysts to elemental sulfur.

For medium-scale gas flows (for sulfur recovered from gas - from 5 tons - 10 tons or more per day), these are catalytic oxidation (redox) processes of the LO CAT type using regenerable catalysts based on iron chelate compounds.

All gas streams up to 1 - 5 tons of sulfur extracted from gas per day are most expediently treated with liquid or solid non-regenerable reagents - absorbers (neutralizers). This practice has long been established and is well known. The most common liquid scavengers in world practice are reagents based on triazines and formaldehyde.

The most common solid absorbers are reagents based on triazines and formaldehyde. The most common solid scavengers are reagents based on iron, zinc or copper oxides.

"Small Capacity Sulfur Recovery Units", By Gary J. Nagl, Merichem, "Oil And Gas Online", July 9, 2010

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ANALYSIS OF EXISTING SOLUTIONS FOR REMOVING HYDROGEN SULFIDE H_2S FROM GAS STREAMS

Way of treat. / Details	Triazine based liquid scavengers	Solid absorbers based on iron oxides, zinc oxides, etc.	Redox systems with a regenerable catalyst based on organic iron compounds	Amine treatment with absorbent regeneration
Process waste	Liquid (can be discharged into the sewer)	Low hazard solid waste	Sulfur as a commercial product	Sulfur as a commercial product
Cost of treatment	$15 per kg of sulfur	$8 per kg of sulfur	$0,6 per kg of sulfur	Insignificant
CAPEX	Low	Medium, relatively low	Relatively high	Very high
Cost-effectiveness for	Up to 500 kg of sulfur per day	Up to 500 kg of sulfur per day	From 5 to 20 tons of sulfur per day	More than 15 tons of sulfur per day

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ECOIL TECHNOLOGIES HAS A SOLUTION

Our company has a patented hydrogen sulfide (H_2S) and mercaptan liquid scavenger ("ECOIL" series), which has significant advantages over triazine scavengers.

The main advantages of our scavengers are:

1. The consumption of our reagent is two times lower than triazines scavengers (1.5g-3g per 1g of hydrogen sulfide (H_2S) or mercaptan sulfur);
2. Absence of disadvantages characteristic of triazine scavengers as insoluble deposits;
3. The reaction products with hydrogen sulfide are water-soluble disulfides S_2^{2-} and polythionates $S_nO_6^{2-}$, stable compounds- non-releasing recombinant hydrogen sulfide (H_2S)/mercaptans, even after acid exposure;
4. The spent reagent is an aqueous solution with anti-corrosion (to hydrogen sulfide corrosion) and bactericidal properties.

Chemical reaction is conversion of H_2S and RSH by Ecoil series scavenger into an aqueous solution of disulfides which can be utilize as an inhibitor of acid corrosion after air regeneration (oxidation of H_2S and RSH to non-toxic sulfides).

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COMPARATIVE ANALYSIS TRIAZINE BASED SCAVENGERS AND ECOIL SERIES SCAVENGERS FOR H_2S AND RSH TREATMENT FROM GAS STREAMS

Usage / Scavengers	Toxicity	Reaction products	Hydrogen sulfide H_2S	Mercaptans RSH	The spent reagent	Other problem
Triazine based	High toxicity (carcinogen)	Insoluble reaction products. Formation of hard-to-remove deposits on the inner walls of pipes, tanks, and others.	Applicable	Ineffective	Hydrolysis of the products of the side reactions- thioformaldehyde and the formation of free formaldehyde in solution. The spent solution has corrosive properties, contains products of side reactions, forming insoluble precipitates.	After sulfuric acid treatment to remove deposits acrid gas with a sharp unpleasant smell is released into the air, causing acute irritation of the respiratory tract and eyes.
ECOIL series	Non-toxic	No	Applicable	Applicable	It has bactericidal and anticorrosive (to hydrogen sulfide corrosion) properties	Mechanical or sulfuric acid treatment is not required

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THREE WAYS OF APPLICATION OF ECOIL SERIES LIQUID SCAVENGER

We use two standard, well-known ways of application for liquid scavengers:

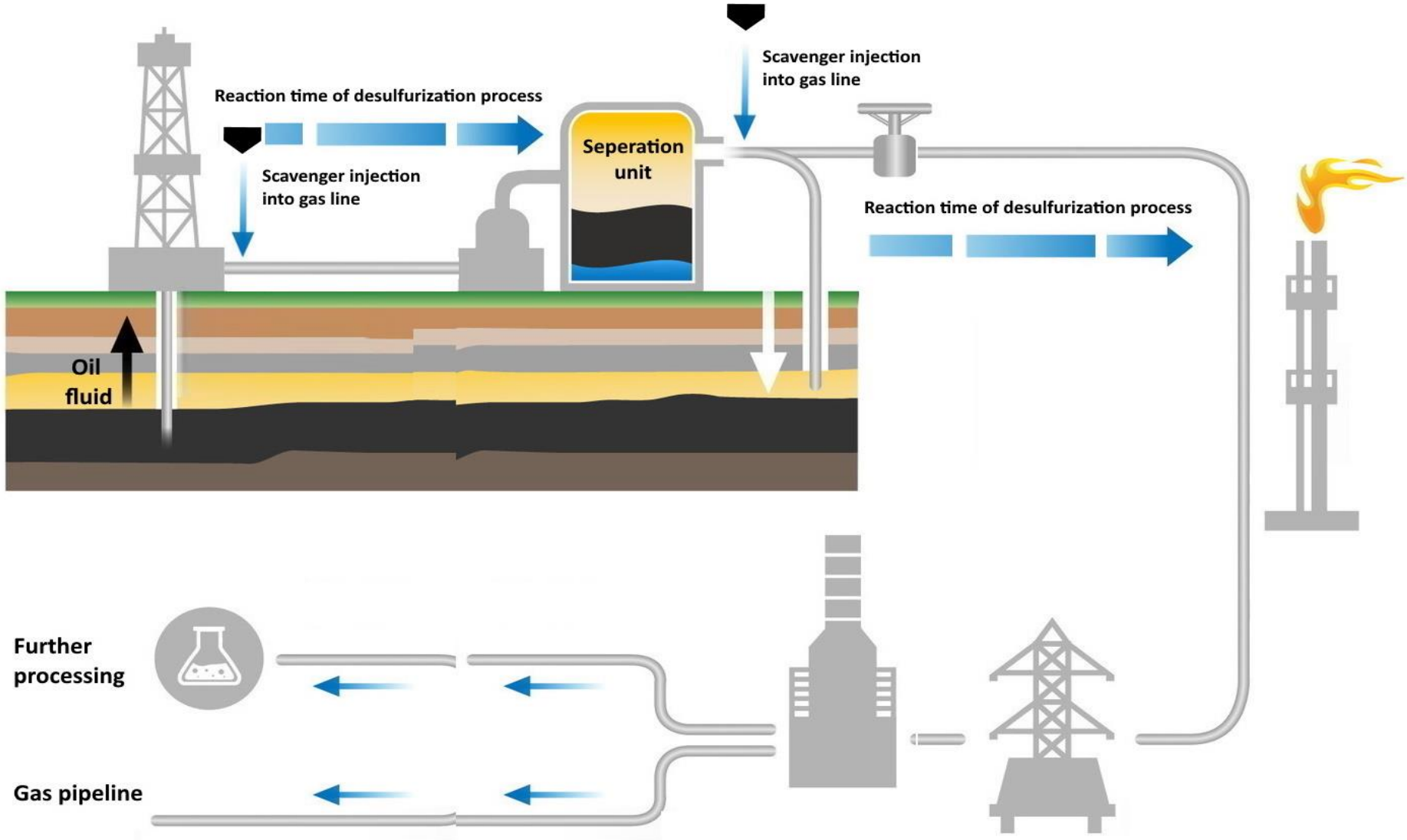
- simply injection into the gas line;
- contact device (unit) filled with scavenger.

Third way is offered only by Ecoil Technologies company, applicable only with our scavenger is **“DOWNHOLE APPLICATION”:**

- injection of scavenger into the wellhead.

INJECTION INTO THE GAS LINE APPLICATION

of ECOIL series scavenger



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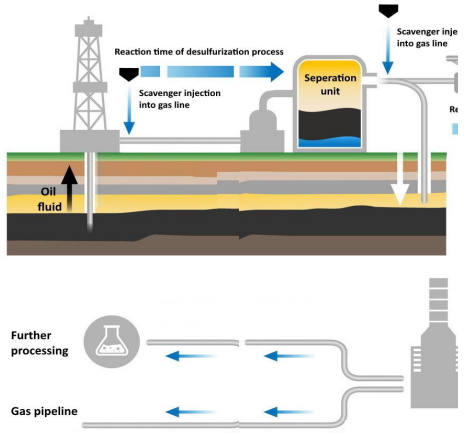
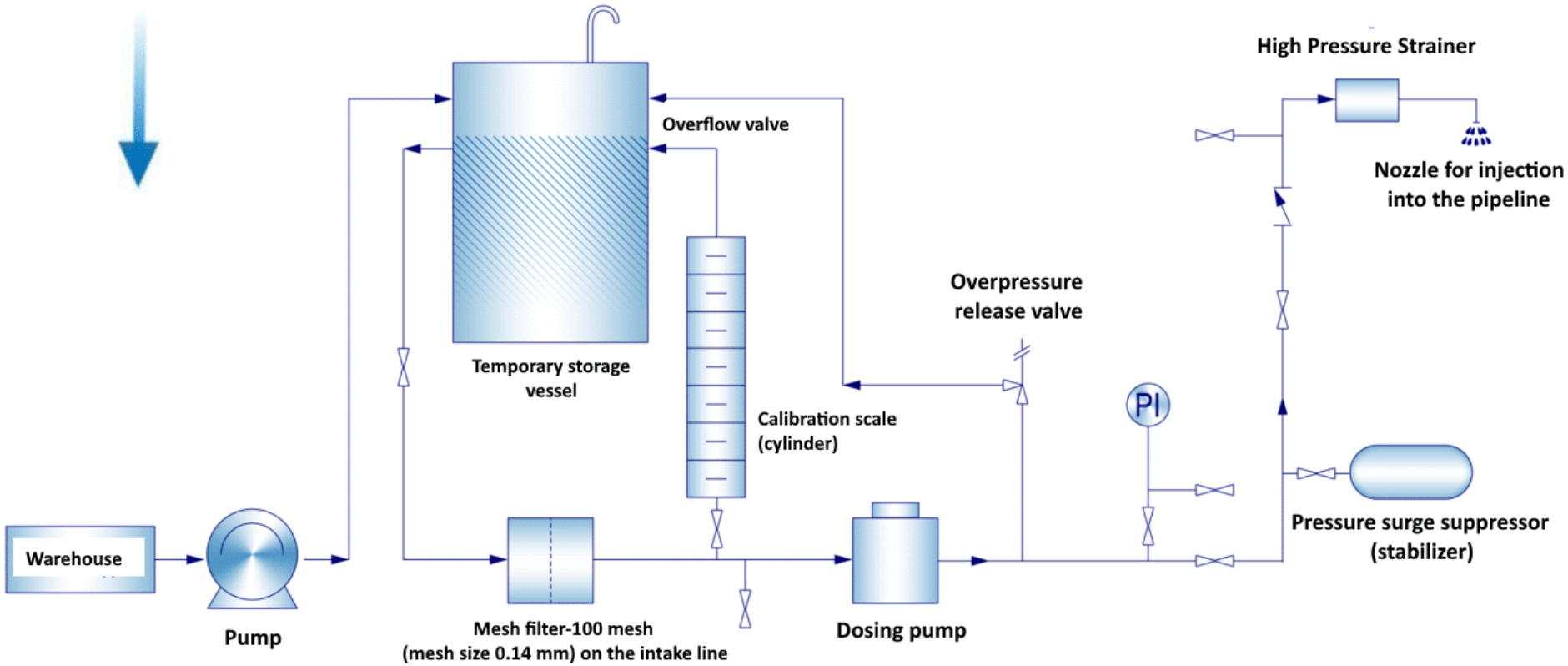
INJECTION INTO THE GAS LINE APPLICATION

of ECOIL series scaver



REAGENT DOSING UNIT OF ECOIL SERIES SCAVENGER



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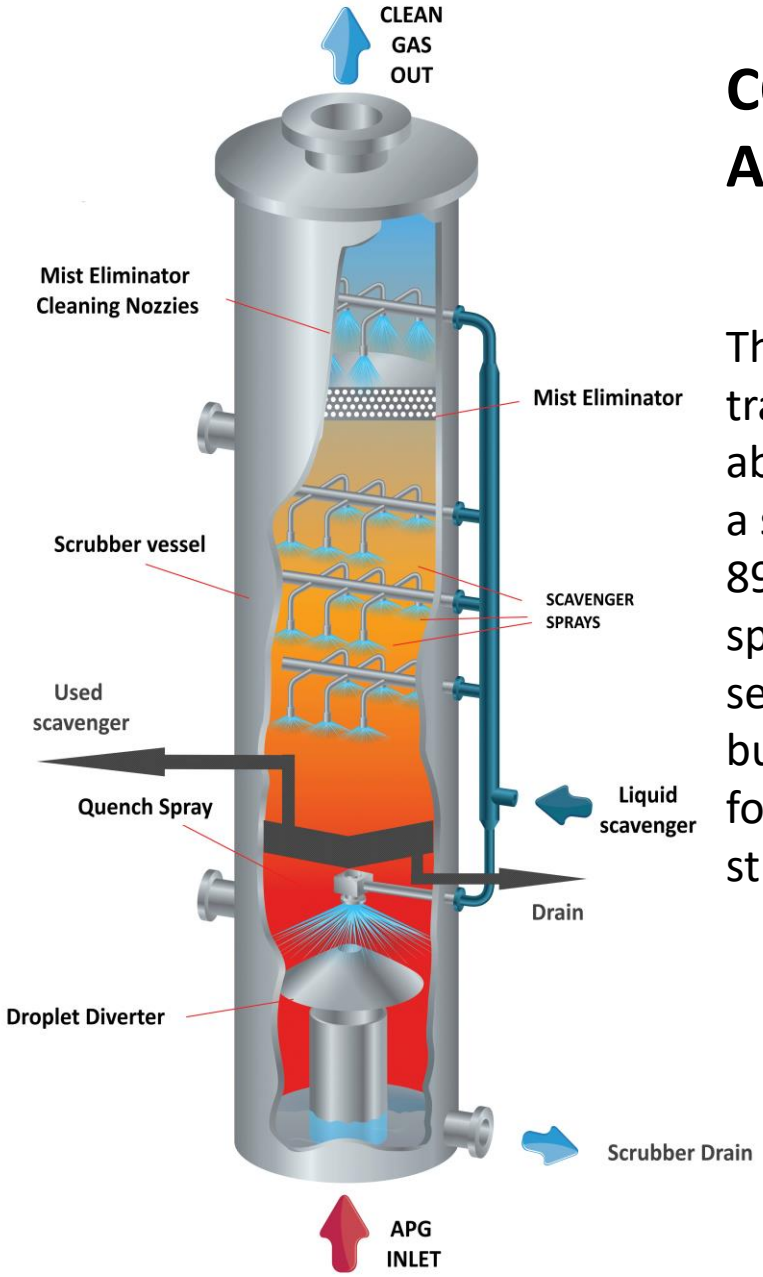

CONTACT DEVICES (UNITS) APPLICATION

The most suitable options for a contactor (mass transfer device) are considered: a surface absorber or a bubbling type with Raschig rings or a saddle-shaped nozzle according to GOST 17612-89 " Acid-resistant ceramic nozzles. Technical specifications", as well as a standard gas-liquid separator with a bubbler installed inside. The bubbler is located horizontally along the lower forming shell of the vessel and is a pipe-in-pipe structure (both perforated).

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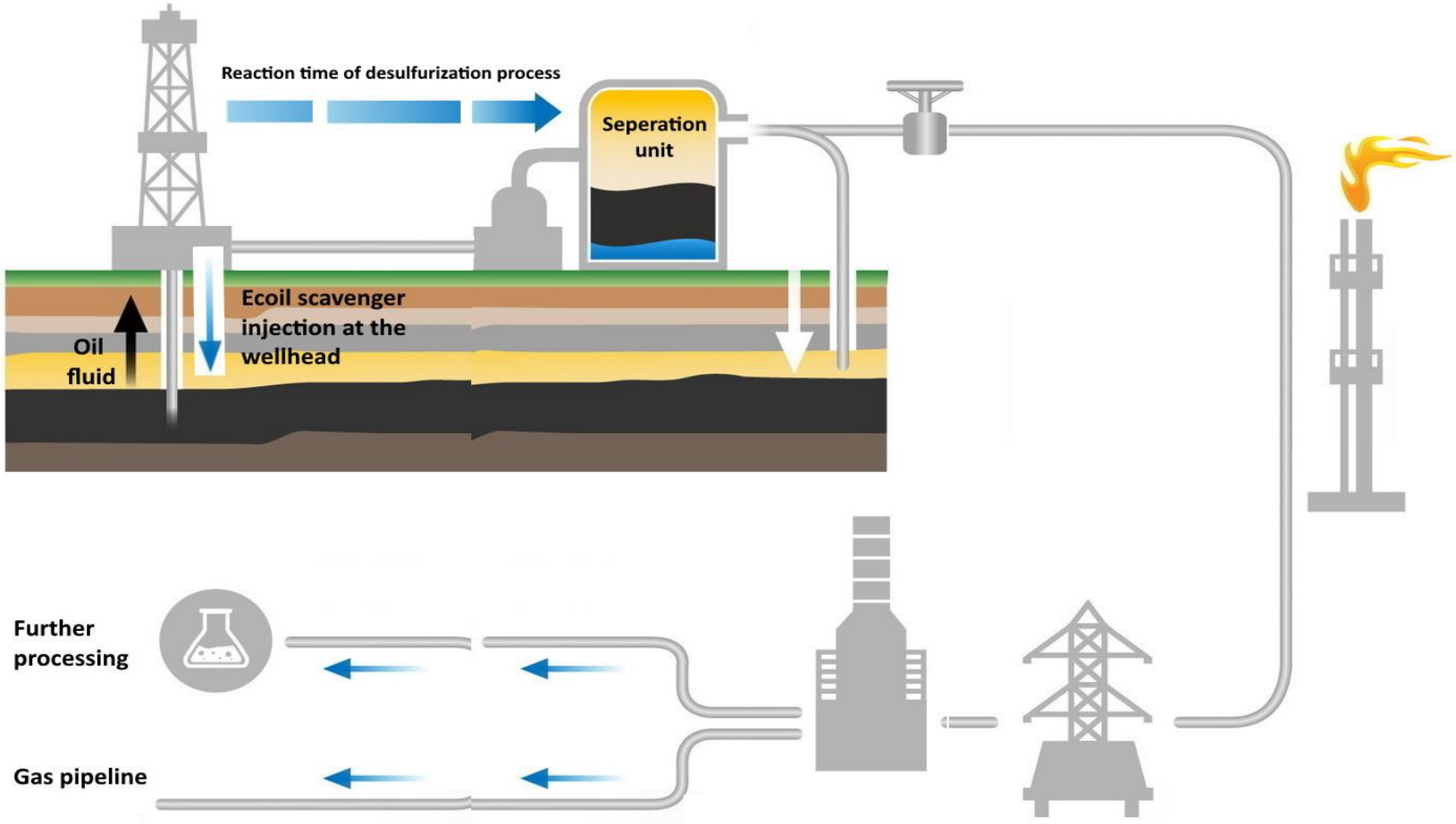
UNIQUE WAY OF DESULFURIZATION

DOWNHOLE APPLICATION

of ECOIL series scavenger



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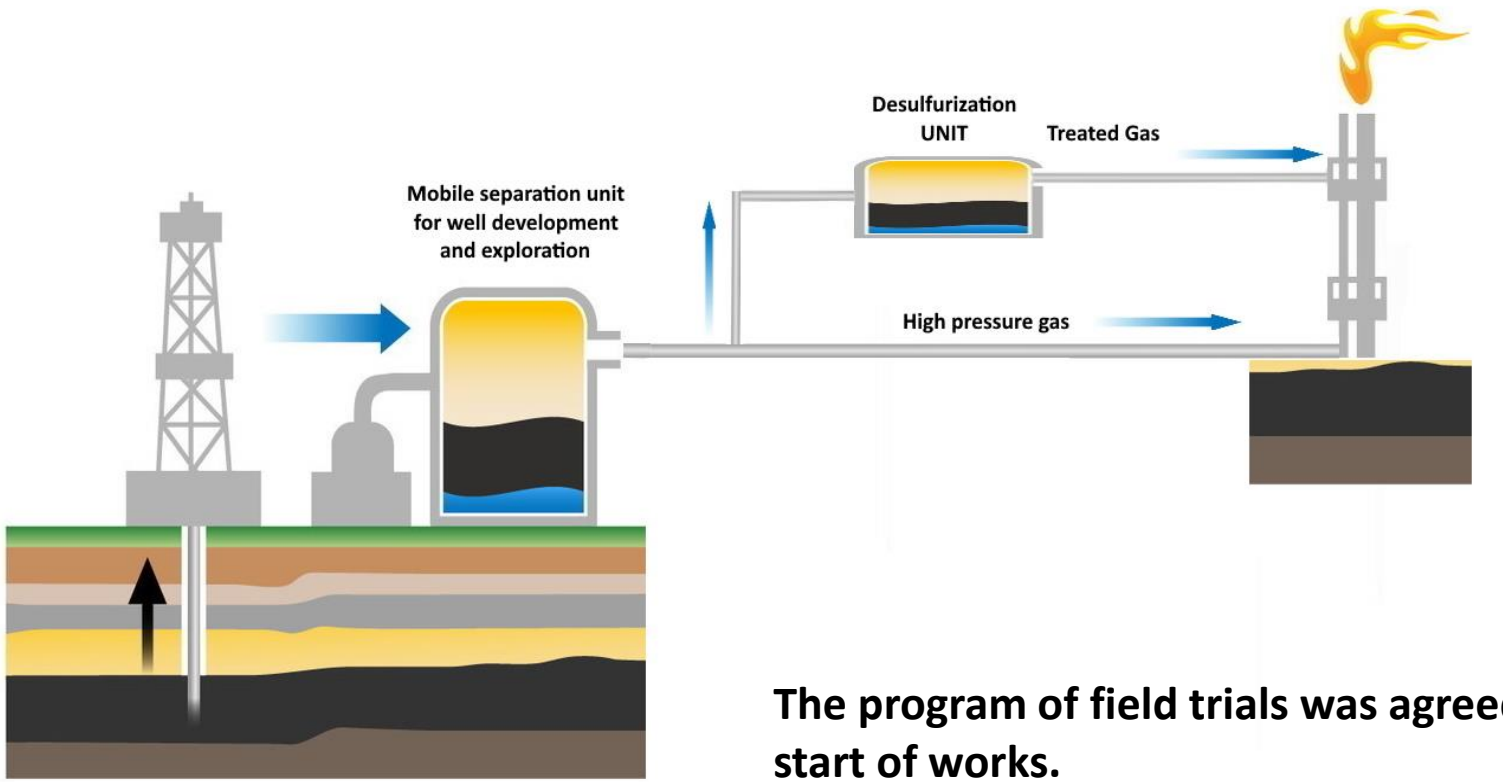
CASE STUDIES

- **Uralnefteservice JSC**, Perm Krai, Russia, www.urlns.ru
  Oil treatment from mercaptans.
- **JSC "TAIF-NK",** Republic of Tatarstan, Russia, www.taifnk.ru
  Treatment of straight-run gasoline from H_2S and improvement of the "copper plate test“ indicator.
- **Kazakhoil Aktobe LLP**, Republic of Kazakhstan, Aktobe, www.koa.kz, Oil treatment from H_2S and mercaptans.
- **Karachaganak Petroleum Operating B. V.,** Republic of Kazakhstan, Aksay, www.kpo.kz, Treatment of gas condensate from mercaptans.
- **Gazprom Dobycha Astrakhan LLC**, Astrakhan Gas Processing Plant, Russia, www.gazprom.ru, Treatment of fuel oil from H_2S and mercaptans.
- **Irkutsk Oil Company LLC**, "Yaraktinskoe oil field", Irkutsk Region, Russia, www.irkutskoil.ru, Treatment of field water from H_2S and mercaptan
- **ARRIS PETROLEUM CORP.,** Delavare, Basin of Texas, USA. APG treatment from H_2S

CASE STUDY- “GAZPROM DOBYCHA ORENBURG” LLC, ORENBURG REGION, RUSSIA, APG TREATMENT FROM H_2S AND MERCAPTANS. FIELD TRIALS DESCRIPTION.

FIELD TRIALS SCHEME



To optimize the technological process of neutralization of gas from hydrogen sulfide (H_2S) and mercaptans was performed field trials of Ecoil series scavenger at well No. 507, unit No. 10, "Gazprom dobycha Orenburg“ LLC.

The main targets of the field trials was:

- effectiveness of technology
- problems during operation
- advantages and disadvantages
- cost of treatment

The program of field trials was agreed and signed by both parties before the start of works.

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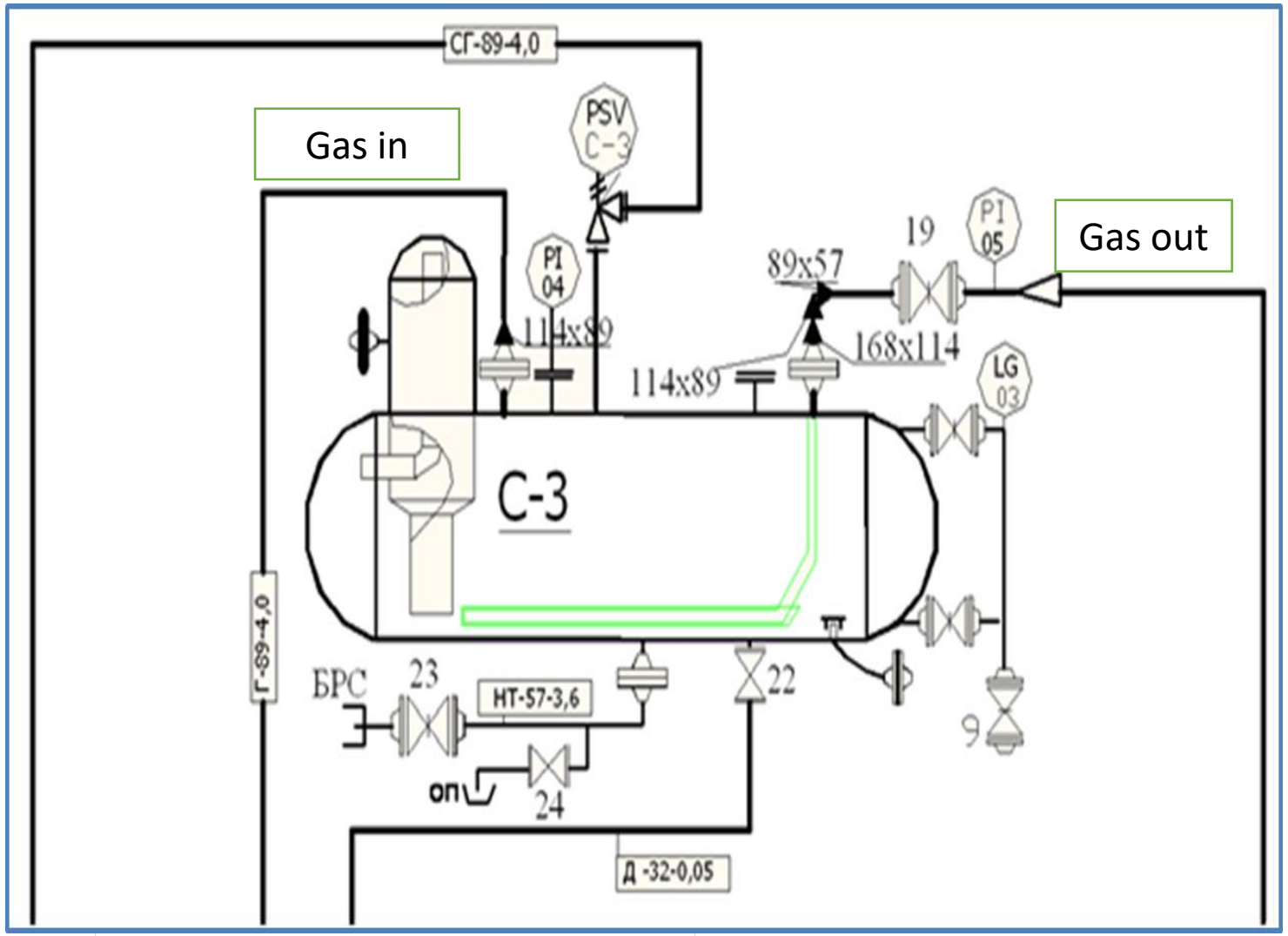
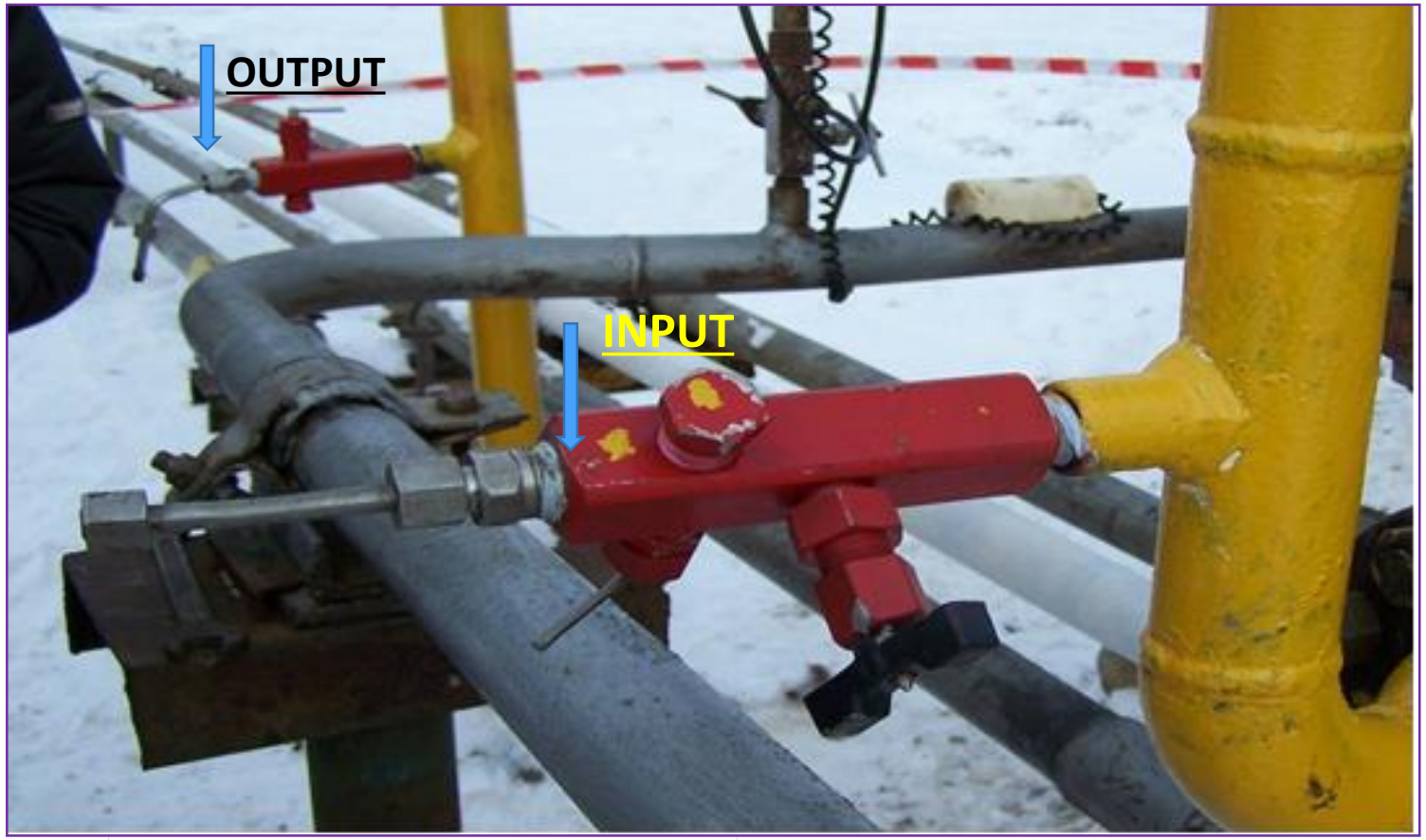


As a mass transfer unit, a separator with a bubbler installed inside was used. The bubbler is located horizontally along the lower forming shell of the vessel and is a pipe-in-pipe structure (both perforated).

PREPARATION OF THE DESULPHURIZATION UNIT



The preparation consisted in connecting the desulphurization unit (BS) to the high-pressure gas discharge line from the primary separator C-1 of the Geo-Test 1 installation. In order to provide laboratory control and express analysis of changes in the degree of gas purification from hydrogen sulfide (H_2S) and mercaptans, sampling points are provided on the input and output lines.

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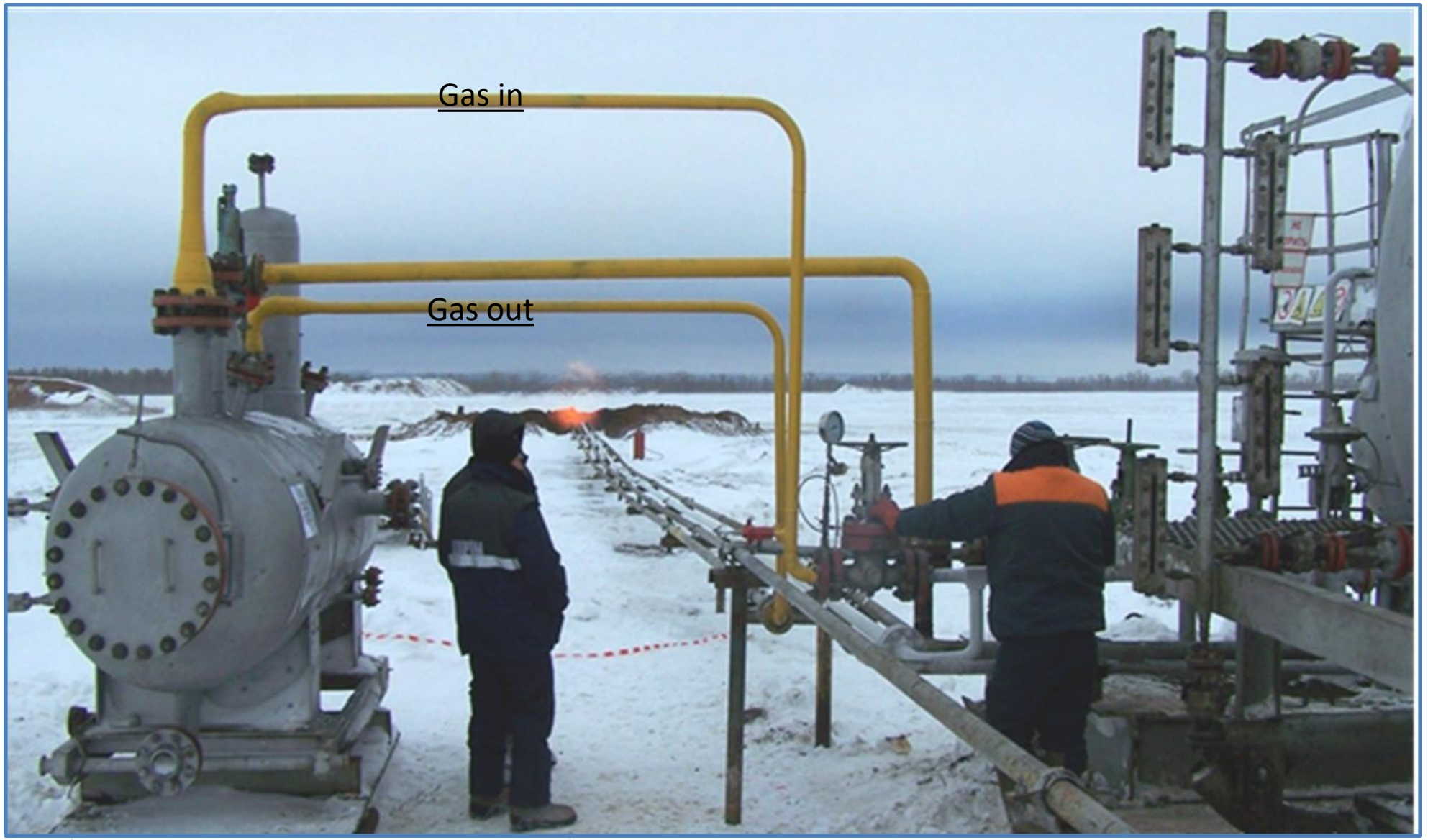

Photo of the field trials of Ecoil series scavenger for gas treatment at the Orenburg oil and gas condensate field.

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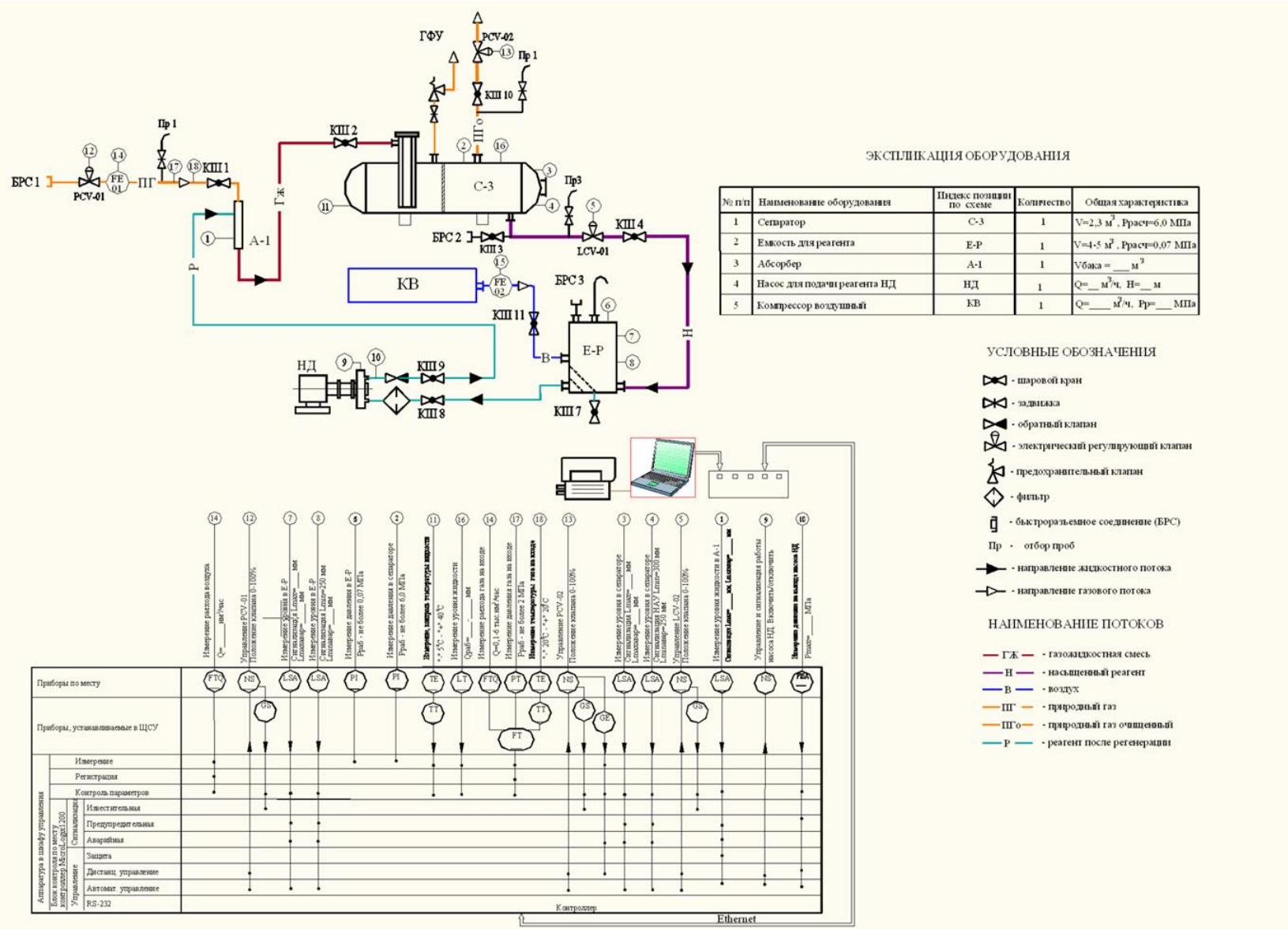
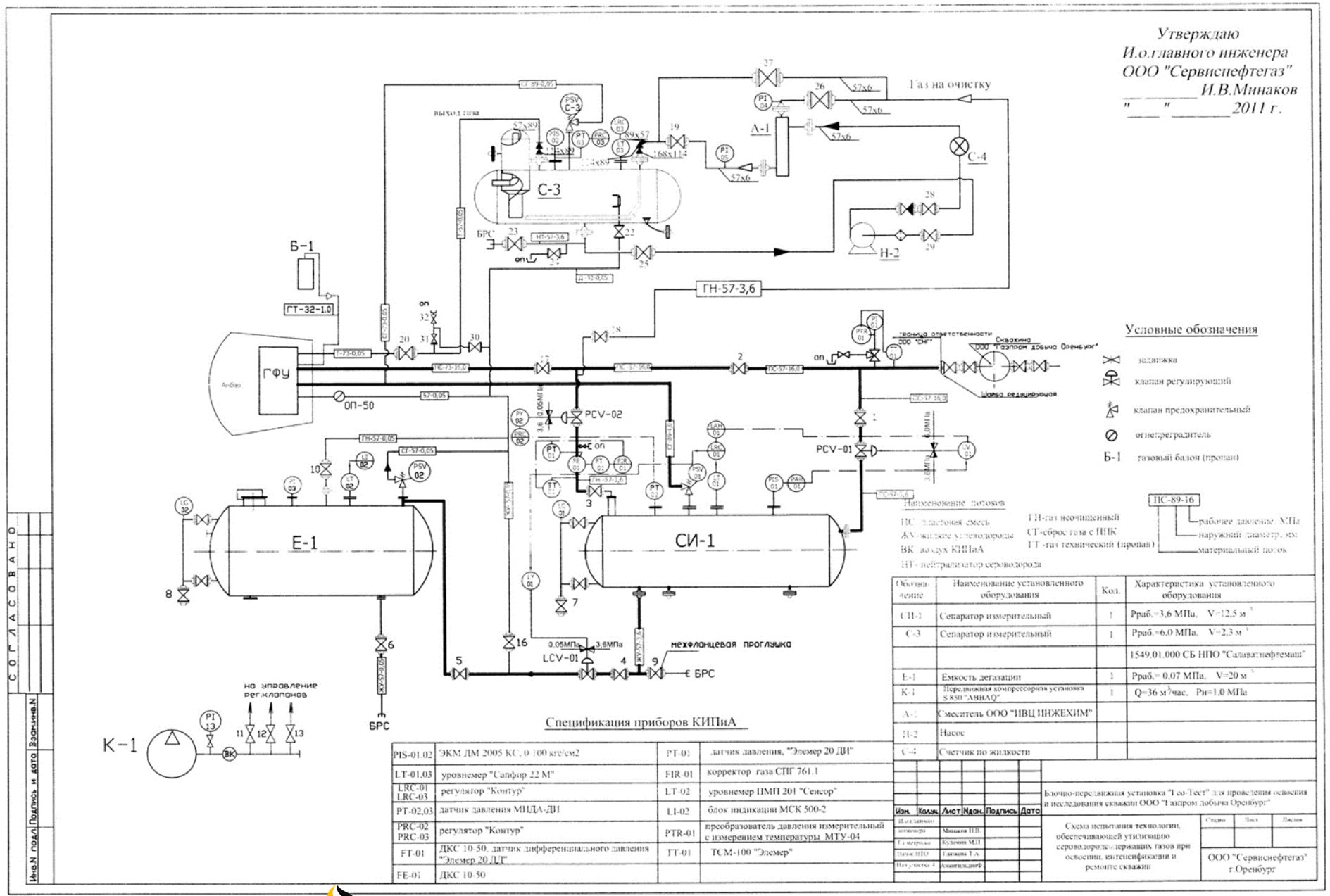


Desulfurization unit scheme, page 1



Спецификация приборов КИПиА

PIS-01,02	"ЭКМ ДМ 2005 КС, 0-100 кгс/см2	PT-01	датчик давления, "Элемер 20 ДИ"
LT-01,03	уровнемер "Сапфир 22 М"	FIR-01	корректор газа СПГ 761.1
LRC-01 LRC-03	регулятор "Контур"	LT-02	уровнемер ПМП 201 "Сенсор"
PT-02,03	датчик давления МИДА-ДИ	LI-02	блок индикации МСК 500-2
PRC-02 PRC-03	регулятор "Контур"	PTR-01	преобразователь давления измерительный с измерением температуры МТУ-04
FT-01	ДКС 10-50, датчик дифференциального давления "Элемер 20 ДД"	TT-01	ТСМ-100 "Элемер"
FE-01	ДКС 10-50		

Обозначение	Наименование установленного оборудования	Кол.	Характеристика установленного оборудования
СИ-1	Сепаратор измерительный	1	Рраб.=3,6 МПа, V=12,5 м³
С-3	Сепаратор измерительный	1	Рраб.=6,0 МПа, V=2,3 м³
			1549.01.000 СБ НПО "Салаватнефтемаш"
Е-1	Емкость дегазации	1	Рраб.= 0,07 МПа, V=20 м³
К-1	Передвижная компрессорная установка S 850 "ДВИАД"	1	Q=36 м³/час, Ри=1,0 МПа
А-1	Смеситель ООО "ИВЦ ИНЖЕХИМ"		
Н-2	Насос		
С-4	Счетчик по жидкости		

Блочно-передвижная установка "Гео-Тест" для проведения освоения и исследования скважин ООО "Газпром добыча Оренбург"

Изм.	Колич.	Лист	Nдок.	Подпись	Дата
Н.контролер		Минаков И.В.			
Гл.инженер		Кузенин М.Н.			
Нач.ПТО		Газизова Т.А.			
Разработал		Ахмадеев Ф.			

Схема испытания технологии, обеспечивающей утилизацию сероводородсодержащих газов при освоении, интенсификации и ремонте скважин

Стадия	Лист	Листов

ООО "Сервиснефтегаз" г.Оренбург

СОГЛАСОВАНО

Инв.N подл. | Подпись и дата | Взам.инв.N

Desulfurization unit scheme, page 2

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DETAILS OF FIELD TRIALS

Pilot tests of the desulphurization technology based on the Ecoil series scavenger were conducted on 06.12.2011 at well No. 507 GPU "Gazprom dobycha Orenburg“ LLC.

The volume of the reagent loaded into the desulfurization unit (DU) was 750 liters., (1/3 of the volume of the DU). The content of inlet Gas H_2S - 5.59%, RSH - 0.27 g/m3.

Photo of express analysis with indicator tubes

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FIELD TRIALS RESULTS

- The hydrogen sulfide H_2S and mercaptans content was reduced to the required values.
- The resource of the scavenger (sulfur capacity) is higher than mainly used scavengers and is approximately 3 g per 1 g of hydrogen sulfide.
- Ecoil series scavenger effectively binds not only hydrogen sulfide, but also mercaptans.
- Ecoil series scavenger does not contain these carcinogenic and toxic substances such as formaldehyde and methanol. Thus there is no danger of air pollution by toxic substances, especially in a period of relief from gas wells with high content of nitrogen and carbon dioxide, i.e. in the period when burning this gas torch is impossible.
- As opposed to Merichem's LO CAT technologies (Redox systems based on the iron (III) EDTA complex), Ecoil series scavenger converts hydrogen sulfide into the liquid form of an aqueous solution of disulfides, without the formation of elemental sulfur and solid sediment.
- The spent absorber has the properties of a passivating corrosion inhibitor. It can be dosed in the gas pipeline or used as a corrosion inhibitor in the system of the increasing of reservoir pressure.
- As opposed to the most common scavengers based on triazines and formaldehyde, Ecoil series scavenger does not form hard-to-remove deposits on the walls of pipes and tanks.
- The field trials results were approved and gas desulfurization technology based on Ecoil series scavenger was recomended for commercial use.

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OUR PRIORITY TASKS

The priority tasks of Ecoil Technologies are achievement of high quality of our product, continuous technological development and scientific research and enabling fulfilment of major integrated projects with maximum economic efficiency for the customer.

In order to let our specialists make the optimal offer to you please fill in the data sheet below with as much detail as possible.

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QUESTIONNAIRE FOR HYDROCARBON GASES TREATMENT FROM H_2S AND MERCAPTANS

Customer name and address	Name and position	Telephone, e-mail

1. Project description and purposes	
1.1. End user (client), name of enterprise, firm etc.	
1.2. Location of the place of application (treatment)	
1.3. Customer authorized representative, telephone and e-mail	
1.4. Project status	
2. General information	
2.1. Feed gas source	
2.2. Gas treatment purpose	
2.3. Current solution for gas treatment (type of equipment and chemicals used)	
2.4. General information of chemical scavenger dosing equipment available in situ (dosing unit on skid, injection nozzle, atomizer, static mixer etc.)	

3. Feed gas parameters	
Parameter*, unit of measurement	Value
3.1. Feed gas resource, m^3/hr (at T=20°C, P=760 mm hg) or other units with the indication of conditions (T, P)	(at T=_____, P=_____)
3.2. Gas pressure, (MPa, kg/cm^2, bar, psi etc - specify)	
3.3. Gas temperature, °C	
3.4. Dew point temperature – water, °C	
3.5. Dew point temperature – hydrocarbons, °C	
3.6. Presence of condensed moisture (water and hydrocarbons), g/m^3 (at working pressure)	
3.7. Presence of mechanical impurities, g/m^3 (at working pressure)	
*For items 3.1 ÷ 3.5 where necessary please specify the parameter variation range.	
3.8. Gas composition, ☐ %mass or ☐%mole (always with the range indication. Steams may be measured in g/m3 (at 20°C, 760 mm hg) or ppm (mass./vol. - specify)	
3.8.1. Hydrogen sulfide (H_2S)	
3.8.2. Mercaptans (RSH)	
3.8.3. Hydrogen (H_2)	
3.8.4. Helium (He)	
3.8.5. Carbon dioxide (CO_2)	
3.8.6. Carbone monoxide (CO)	
3.8.7. Nitrogen (N_2)	
3.8.8. Oxygen (O_2)	
3.8.9. Methane (CH_4)	
3.8.10.Ethane (C_2H_6)	

3. Feed gas parameters	
3.8.11.Propane (C_3H_8)	
3.8.12.Isobutane	
3.8.13. n-Butane	
3.8.14. Isopentane	
3.8.15. n-Pentane	
3.8.16. Hexane	
3.8.17. Heptanes	
3.8.18. Octanes and higher	
3.8.19. Benzene	
3.8.20. Toluene	
3.8.21. Methanol	
3.8.22. Water	
3.8.23. Other components (indicate if more than 1ppm)	
3.9. Salt content	
3.10. pH value	
4. Treatment conditions	
4.1. Existing equipment for gas pre-treatment: separators, filters etc with specifications	

4. Treatment conditions	
4.1. Existing equipment for gas pre-treatment: separators, filters etc with specifications	
4.2. General description of the application (downhole applications in borehole, at the head of wellbore - well fluids treatment before dewatering unit, dry gas after water separation, petroleum associated gas after degassing unit, storage tank, marine terminal, upstream applications in petroleum refinery plant, fuel gas etc.)	
4.3. Contact time (retention time – the approximate time which is estimated to take the gas to get from the chemical injection place to the H2S monitoring place)	
5. Treated gas requirements	
5.1. Special requirements to treated gas (compliance with STO (OST, GOST), permissible content of certain components, content of target component.	
5.2. Hydrogen sulfide (H2S)	
5.3. Mercaptans (RSH)	
6. Additional information / requirements	
6.1.	

THANK YOU

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