

أسلوب جديد لتكنولوجيا الصرف الصحي الرغوي لبئر الغاز مع السائل المتراكم

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الخلاصة

تم استخدام تكنولوجيا الصرف الصحي الرغوي على نطاق واسع في إزالة السائل من الأنبوب في بئر الغاز مع السائل المتراكم والحفاظ على العمل العادي للبئر. ولكن إن لديه تحديات في تطبيق هذه العملية، خاصة لبئر الغاز في درجة الحرارة المنخفضة وفي المكان النائي التي يحدث إنسداد الأنبوب بسهولة. عادة ما يتم حماية هذه الآبار من تركيب جهاز العزل الحراري وحقن جليكول الإثيلين على فوهة البئر، والذي يحد تطبيق هذا التكنولوجيا. تطرح هذه المقالة الأسلوب الجديد لتكنولوجيا الصرف الصحي الرغوي الذي يتميز بالمزايا التالية من أجل مواجهة هذه التحديات: (1) إنه يحافظ على نزاهة المعدات الأصلية لتجنب العملية المعقدة في فوهة بئر الغاز الطبيعي؛ (2) إنه يحل مشكلة الذوبان بين مزيل الرغوة وجليكول الإثيلين. إن إزالة الرغوة بجهاز حقن جليكول الإثيلين لا يحافظ على فعالية عملية حقن جليكول الإثيلين فحسب، بل يحل المشاكل الصعبة لإزالة الرغوة في تكنولوجيا الصرف الصحي الرغوي؛ (3) بالنسبة الي الخليط من مزيل الرغوة وإيثيلين جلايكول، يمكن لهذا الأسلوب الحفاظ على الأداء الأصلي لمقاومة التجمد وإزالة الرغوة التي تم وضع الأساس لتطبيق الأسلوب الجديد؛ (4) إن التكاليف الرئيسية للأسلوب الجديد هي تكلفة المواد الكيميائية مما يجعلها أكثر إقتصادا بالمقارنة مع غيرها من التكنولوجيات. وبالإضافة الي ذلك، تم اختبار هذا الأسلوب في بئر الغاز مع المياه المتراكمة الشديدة، أظهرت النتائج عدم وجود الانسداد والرغو في فوهة بئر الغاز التي يعيد الإنتاج في النهاية. إلى جانب ذلك، يتم تقليل مرات إغلاق البئر بشكل كبير بعد تطبيق هذا الأسلوب الجديد. تشير دراستنا الي أنه يمكن للأسلوب الجديد أن ينتشر في بئر الغاز بدرجة الحرارة المنخفضة وفي المكان النائي إذا تم اختيار عامل الإرغاء، مزيل الرغوة وعامل المتحسب المناسب.

A new method of foam drainage technology in loading gas well

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ABSTRACT

Foam drainage technology has been widely used to remove the liquid out of pipe in loading gas wells and keep the well normally producing. Still, it has some limitations in application, especially for the wells in low temperature and remote areas, in which the pipe blocking disasters easily occur. Moreover, these wells are usually protected by the attemperator and ethylene glycol injection in the wellhead, which further hinders the application of this technology. Faced with these limitations, we propose a new method, which has the following advantages: (1) it keeps the original devices, avoiding the complex wellhead operation; (2) it solves the problem of hard dissolvability of originally injecting ethylene glycol and newly injecting defoamer. Additionally, it makes use of the ethylene glycol injecting equipment as co-defoaming process. It not only keeps the ethylene glycol injecting effectively, but also solves the big problem of defoaming in foam drainage; (3) for the mixed liquid of ethylene glycol and defoamer, the abilities of anti-freezing and defoaming are maintained in the new method, which is the base of application; (4) the main costs of the new method are the expense of necessary chemical agents, making the method quite economical. Further, the new method was applied into the severely loading gas well. It turned out that there was no block and no foam in the wellhead and the well had been brought back to life. Besides, the frequency of shut-in was reduced by a large extent. Our study suggests that the new method could be popularized in remote and low temperature gas wells if suitable foamer, defoamer, and emulsifier could be obtained.

Keywords: foam drainage; ethylene glycol injection; anti-freeze; defoaming.

INTRODUCTION

With the development of normal gasfield, the reservoir pressure declines and gas production reduces, resulting in the lower carrying ability of gas flow. This in turn may cause liquid loading in the borehole and hinder the well producing effectively, and even kill the well. Therefore, adopting the drainage technology to remove the loading liquid timely is of great significance to keep the well alive and promote single well production (Schiferli et al., 2010). Nowadays, there are many kinds of drainage technologies with different costs, which cater to different loading wells. The frequently-used technologies are as follows: foam drainage (Leaet et al., 2008), pipe diameter optimizing (Coleman et al., 1991; Skopichet et al., 2013), gas lifting (Sukarnoet et al., 2009), hydraulic jet (Hai-Yan et al., 2014), and plunger lifting (Luo et al., 2014).

Among these technologies, foam drainage technology, which is composed of foaming process

and defoaming process, is now widely adopted in gas wells, owing to its high efficiency and low cost. Despite of these advantages, it still has some limiting factors such as salinity, oil cut of loading liquid, and environmental temperature. As high salinity and high oil cut of loading liquid could be solved by utilizing the compatible foamer and defoamer, the most difficult problem lies in the low environmental temperature. This may result in the forming of ice and hydrate, which would block the pipe and severely impede the normal production.

It is generally known that many gas wells are located in the remote districts such as desert, and the annual average temperature could be below zero. Hence, the wells are usually protected by the attemperator or ethylene glycol injection in the wellhead, which cannot be removed during the producing period in case of the forming of ice and hydrate. In addition, it is dangerous to connect the new foaming and defoaming apparatus to the wellhead under high pressure of gas wells.

In this paper, we propose a new method without disturbing the original pipes. By using the new method, the costs can be minimized to a large extent, the foamer can be added manually, and the defoaming efficiency could also be guaranteed.

MATERIALS AND METHODS

The proposed method is illustrated in Figure 1. The key point of the new method lies in the defoaming process. We propose the use of the original ethylene glycol injecting equipment as co-defoaming process (the nature of ethylene glycol and information are described in APPENDIX). In this sense, the defoamer should be integrated with the ethylene glycol, the mixed liquid of ethylene glycol and defoamer should be mutually dissolvable, the rate of ethylene glycol recycling should also meet the need, and the effect of anti-freezing and defoaming should be maintained.

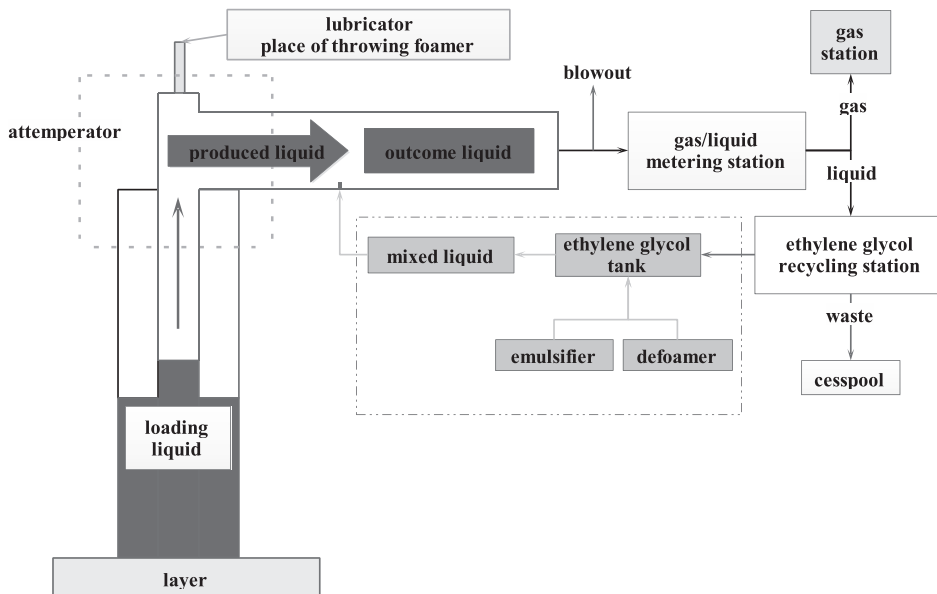


Figure 1. Diagrammatic sketch of proposed method. The dashed frame showed the differences between the new method and normal methods (only ethylene glycol in the ethylene glycol tank in normal system).

2.1 FOAMER AND FOAMING PROCESS

There are many ways of adding the foamer, such as electric pump and foaming vehicle (Leaet et al., 2008), among which the most economical way is to add the clubbed foamer manually from the lubricator in Figure 1. The previous study has demonstrated that this is the only way of carrying out the foaming process without disturbing the pipe string (Fen-Fen et al., 2012).

2.1.1 FOAMER SENSITIVITY

As the primary step of foam drainage technology, selecting the adaptive foamer is the prerequisite. Suitable foamer was expected to react with the loading liquid by large extent, which could make the density much lower and make the loading liquid much easier to be carried out of pipe to the wellhead (Figure 1).

The loading liquid from the testing well was collected three times, named No.1 sample, No.2 sample, and No.3 sample, respectively. No.1 sample was chosen as the example for illustration. No.1 sample was collected in November 2014 from the wellhead. The indoor distilling analysis showed that the sample contained 4.1% condensate oil, 17.3% ethylene glycol, 75.6% water, and 3% sand and waste. The little condensate oil and much ethylene glycol contained in the sample might have exerted influence on the foaming height and foam stability, which would ask for high resistance of condensate oil and ethylene glycol towards the foamer.

The normal method of Ross-Miles (You-Jie et al, 2016) was chosen in this study. The loading liquid was used as solvent and six kinds of foamer UT-4,UT-6,UT-10B,FC-117,UT-10A, and CL-100 (the nature of the foamers and information are described in APPENDIX) were used as the solute. 300ml No.1 sample reacted with different foamer of varying mass fraction under (the average temperature of the reservoir is about 104°F).

Shown in Table 1, the foamers UT-10B,UT-6, and CL-100 were effective. As the foam stability of UT-10B was much stronger than the others and could maintain relatively a long time (Table 1), it was the most adaptive one and the compatible mass fraction was 0.3%~0.4%.

Table 1. Foaming heights of No.1 sample with foamer of varying mass fractions.

Foamer name	Mass fraction (%)	Foaming height(mm)			Foamer name	Mass fraction (%)	Foaming height(mm)		
		30s	3min	5min			30s	3min	5min
UT-4	0.1	40	20	5	UT-6	0.1	95	80	55
	0.2	90	25	5		0.2	155	130	95
	0.3	95	40	10		0.3	195	180	160
	0.4	105	50	15		0.4	215	190	185
	0.5	100	45	25		0.5	210	180	175
UT-10B	0.1	75	60	35	FC-117	0.1	70	35	15
	0.2	120	80	60		0.2	115	55	35
	0.3	195	200	200		0.3	145	70	40
	0.4	200	190	180		0.4	160	85	45
	0.5	195	185	175		0.5	155	80	40
UT-10A	0.1	65	25	5	CL-100	0.1	140	115	95
	0.2	80	30	5		0.2	155	135	115
	0.3	100	35	10		0.3	200	190	165
	0.4	140	55	20		0.4	215	195	185
	0.5	135	50	15		0.5	210	190	175

2.1.2 EFFECT OF ETHYLENE GLYCOL ON FOAMING

In order to prevent the forming of hydrate and ice in the wellhead and producing string, it is used to inject ethylene glycol in the wellhead. Although the defoaming ability of ethylene glycol can hinder second-foaming to some extent, which is helpful for the produced liquid directly entering the producing string, and reduce the danger of bubble flow along the producing line, it is not complete.

To explore the effect of ethylene glycol on foaming, different mass fraction of ethylene glycol solvent was made with a volume of 300ml. Then 0.9g foamer UT-10B was added in each ethylene glycol solvent. After that, Ross-Miles experiment was performed to test the foaming heights during 30s, 3min, and 5min separately under 50°F (the wellhead temperature is nearly 50°F when the environmental temperature is below zero), the experimental results are listed in Table 2.

Table 2. Foaming heights with different mass fractions of ethylene glycol (%).

Amount (ml)	Mass fraction of ethylene glycol(%)	Foaming height(mm)		
		30s	3min	5min
300	0	210	190	170
	10	200	170	120
	20	190	140	80
	30	150	80	40
	40	120	60	20
	50	100	20	10

In Table 2, it could be seen that the second foaming was more depressed with the rise of ethylene glycol mass fraction, which suggests that injecting ethylene glycol could partly play a role in defoaming the produced liquid in the wellhead.

However, it is dangerous if the defoaming process is not complete as the bubble phase flow in the producing line could hinder the transportation of produced liquid and gas, and cause huge pressure loss along the string. Eventually, it may kill the natural gas/liquid metering station or the whole producing grid (Ajani et al., 2016; Van-Nimwegen et al., 2016). Therefore, special defoamer was needed to defoam the produced liquid completely.

2.2 DEFOAMER AND DEFOAMING PROCESS

Similar to foaming process, defoaming process can be realized in many ways, such as defoaming vehicle and solid defoaming device (Leaet et al., 2008). However, the testing well is far from the city center, and it is not reasonable and feasible to adopt these defoaming processes by taking the risk of removing the attenuator or ethylene glycol injecting facility during the period of low temperature. Furthermore, it takes a long time to connect new foaming and defoaming devices to the wellhead, which is not permitted especially when the original hardware of facility runs in good state. An ideal way is to utilize the original ethylene glycol injecting device as co-defoaming.

The selection of the defoamer, contrary to the foamer selected above, should take zero-height of second foaming as the standard. Defoaming experiment was conducted with the widely used defoamers N1, N2, N3, N4, N5, and N6 (the nature of the defoamers and information are described in APPENDIX), which was used to defoam the foaming liquid in section 2.1.1 during 50°F. The procedures were visualized in Figure 2. In this experiment, the defoaming liquid was made with different mass fractions and amount, and the zero-second-foaming was chosen as standard. No.1 sample with 0.5% mass fraction of defoamer liquid was taken as the example, and the results were shown in Table 3.

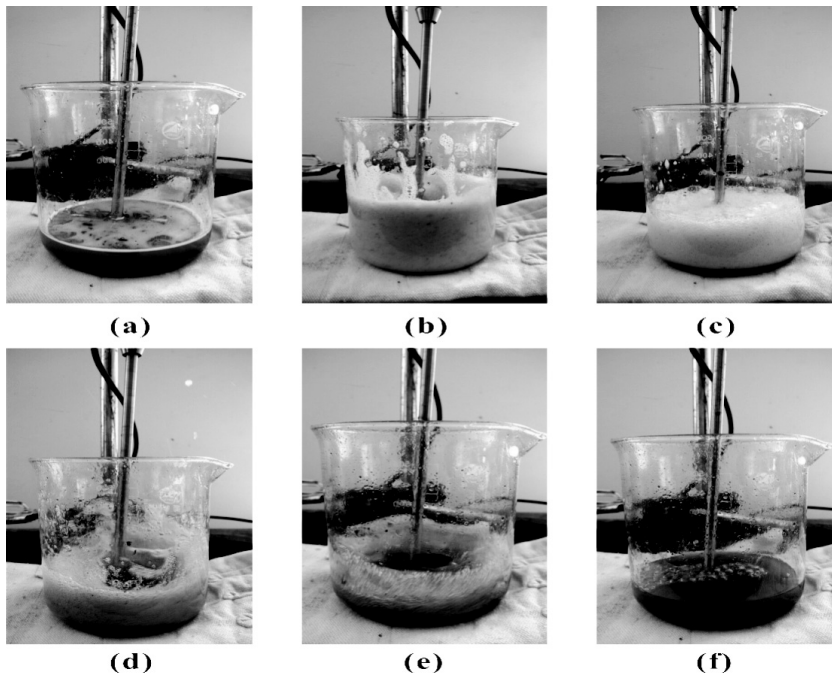


Figure 2. Deforming process of N4: (a) starting up; (b) stirring with 3000r/min; (c) 1ml amount of defoamer; (d) 2ml amount of defoamer; (e) stirring with 3000r/min and (f) stop stirring.

Table 3. Defoaming data of different defoamers against foamer UT-10B.

Foamer name	Foamer mass fraction (%)	Defoamer name	Defoamer mass fraction(%)	Amount of defoamer solvent(ml)
UT-10B	0.3	N1	0.5	3
		N2		—
		N3		6
		N4		2
		N5		3
		N6		—

'—' represented that the defoamer had no effect on defoaming the foaming liquid.

As seen from Table 3, defoamer N4 was much more effective than the other defoamers. Based on the whole defoaming experiments, defoamer N4 was the most adaptive, the suitable mass fraction was about 0.5%, and second foaming could hardly occur. All in all, through the optimal experiments, the foamer UT-10B and defoamer N4, with mass fractions of 0.3%~0.4% and 0.5%, respectively, were chosen.

As injecting ethylene glycol has some effect on defoaming the produced liquid in the wellhead, a new method based on the original devices to integrate the original ethylene glycol and newly injecting defoamer is needed. Only in this way can the original apparatus be maintained and the

produced liquid be defoamed completely in the wellhead. The ethylene glycol and defoamer should be tested for the possibility of integration before the new method could be applied.

2.2.1 DISSOLVABILITY OF ETHYLENE GLYCOL AND DEFOAMER

According to the Principle of Similar Compatibility (Fadili et al., 2009; Hocine et al., 2016), ethylene glycol is compatible with water, ethanol, acetone, and so on. It is generally known that the active ingredient of widely used defoamer is composed of oil solute substance. Therefore, there is no possibility for the reaction of ethylene glycol and defoamer without radical groups, which means that the defoamer may have a bad diffusivity in ethylene glycol.

As shown in Table 4, the experimental defoamers were hardly dissolvable in ethylene glycol. N4 displayed a bad dissolvability in ethylene glycol, which hindered the integration of them.

Table 4. Dissolvability of defoamer N4 and ethylene glycol (under).

Ethylene glycol(ml)	Defoamer name	Maximal amount of dissolvability(ml)
20	N1	0.02
	N2	0.04
	N3	0.03
	N4	0.02
	N5	0.01
	N6	0.03

2.2.2 INTEGRATING EXPERIMENT

In order to solve the dissolvability of ethylene glycol and N4, we proposed to emulsify them. In this way, the original ability of ethylene glycol and defoamer could be maintained. After trying many emulsifiers, we finally solved this problem with emulsifier OP-10 (the nature of emulsifier OP-10 and information are described in APPENDIX; it has wide emulsibility and universality in Chemical Engineering) without losing the anti-freezing and defoaming abilities of the mixed liquid.

From Figure 3, it could be seen that the ethylene glycol and defoamer could be mutually dissolvable when the mass proportion of emulsifier and defoamer was 1:1, and there was no floccule. If the proportion of emulsifier was too small, it would fail to reach the standard of defoaming the produced liquid.

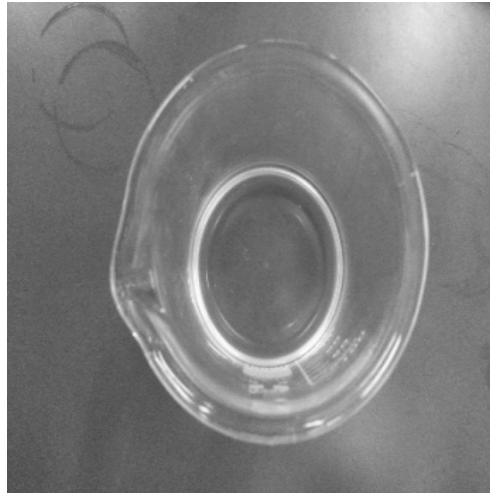


Figure 3. Phenomenon of dissolvability in ethylene glycol with equal mass of defoamer and emulsifier.

2.2.3 DEFOAMING TEST OF MIXED LIQUID

Using the mixed liquid of ethylene glycol, defoamer, and emulsifier to defoam the produced liquid under 50°F, similar procedures in the selection of defoamer were performed. The outcome liquid included produced liquid and mixed liquid (Figure 1). Taking No.1 sample as the example, the results were shown in Table 5.

Table 5. Defoaming test of mixed liquid.

Produced liquid (ml)	Mixed liquid (g)	Phenomenon
300	0.01	Not completely defoaming
	0.02	Not completely defoaming
	0.03	Completely defoaming
	0.04	Completely defoaming with sediment
	0.05	Completely defoaming with sediment
	0.06	Completely defoaming with sediment

From Table 5, it could be seen the integrated liquid had a great effect on completely defoaming, and the suitable proportion was 0.03g mixed liquid towards 300ml produced liquid, which revealed that the integration of ethylene glycol, defoamer, and emulsifier was feasible. In short, the emulsifier OP-10 could improve the dissolvability of defoamer N4 in ethylene glycol and the defoaming effect was still maintained.

2.2.4 ANTI-FREEZING TEST

When the produced liquid reaches the wellhead, the integrated liquid of ethylene glycol, defoamer, and emulsifier can defoam it completely in the wellhead. However, it is still not sure if the ability of anti-freezing is enough for transporting the mixed liquid and outcome liquid.

In order to elucidate the anti-freezing ability of mixed liquid, a test was carried out. Four solutions of 50ml mixed liquid with different fractions of ethylene glycol were made. The LGJ-18 lyophilizer (Antifreezing Testing Device, Model BiLon co., Shanghai, China) was used to conduct the experiment. 0.25g N4 and 0.25 OP-10 were added to each sample before putting them into the lyophilizer to test the ability of anti-freezing. The results were shown in Table 6.

Table 6. Anti-freezing ability of mixed liquid.

Temperature (°C)	Fraction of ethylene glycol(%)	Fraction of water (%)	Amount of N4(g)	Amount of emulsifier (g)	Phenomenon
-20	30	70	0.25	0.25	Not freeze
-30	40	60	0.25	0.25	Not freeze
-40	50	50	0.25	0.25	Not freeze
-50	50	50	0.25	0.25	Not freeze

As seen from Table 6, the mixed liquid of ethylene glycol, defoamer, and emulsifier still kept the anti-freezing ability; it could flow easily from the ethylene glycol tank to the wellhead under , which ensured the normal injecting process.

In order to elucidate the anti-freezing ability of the outcome liquid, another test was carried out. 50ml solutions of outcome liquid of No.1 sample, foamer, ethylene glycol, defoamer, and emulsifier, with the mass fraction of ethylene glycol ranging from 30% to 50% (the ethylene glycol ratio in gas/liquid metering station is below 50%) were made. The LGJ-18 lyophilizer was used to test the antifreezing ability of outcome liquid. The antifreezing ability test results were shown in Table 7, and the phenomenon of outcome liquid with 33% ethylene glycol under was shown in Figure 4.

Table 7. Anti-freezing test of outcome liquid.

Temperature (°C)	Fraction of ethylene glycol(%)	Fraction of No.1 sample (%)	UT-10B (g)	N4 (g)	Emulsifier (g)	Phenomenon
-20	29	71	0.2	0.25	0.25	Not freeze
-30	29	71	0.2	0.25	0.25	Not freeze
-40	29	71	0.2	0.25	0.25	Light multiviscosity
-50	29	71	0.2	0.25	0.25	Light multiviscosity



Figure 4. Anti-freezing ability of outcome liquid with 33% ethylene glycol under .

As seen from Table 7 and Figure 4, the outcome liquid of No.1 sample, foamer, ethylene glycol, and defoamer could transport safely from the wellhead to the gas/liquid metering station under . Meanwhile, as the flow is in high speed, it made the liquid freezing much more tough, which was beneficial to the normal producing process.

2.3 EFFECT ON ETHYLENE GLYCOL RECYCLING

Huge amount of ethylene glycol can be quite expensive. The natural gas gathering station commonly recycles the ethylene glycol by distilling and the recycling ratio can reach 75%~80%.

In the new method, the outcome liquid (Figure 1) should not hinder the recycle. The recycling process distilled 300g outcome liquid under. As seen from Table 8, the additional foamer, defoamer, and emulsifier had little influence on recycling the ethylene glycol.

Table 8. Recycling of ethylene glycol from outcome liquid.

Mass of mixed liquid (g)	Mass of foamer (g)	Mass of defoamer (g)	Mass of water (g)	Mass of ethylene glycol(g)	Recycling ratio (%)
327	1.2	2	85	240	73.4
311	1.2	2	88	223	71.7
306	1.2	2	90	214	69.9

According to the results, the recycling ratio could reach 73.4%. Meanwhile, the outcome liquid from a single well could hardly hinder the recycling ratio of the whole gas gathering station, and it was feasible in the permitted precision, which means that the additional chemical agents would not affect the whole producing process.

3 ON-SITE APPLICATION

3.1 PERFORMANCE OF TESTING WELL BEFORE APPLICATION

The tubing pressure of testing well fluctuated greatly from November 2012 to August 2014, and daily gas production varied. According to the on-site record, the liquid production was about $2\text{m}^3/\text{d}$. The performance was shown in Figure 5 before adopting the new method.

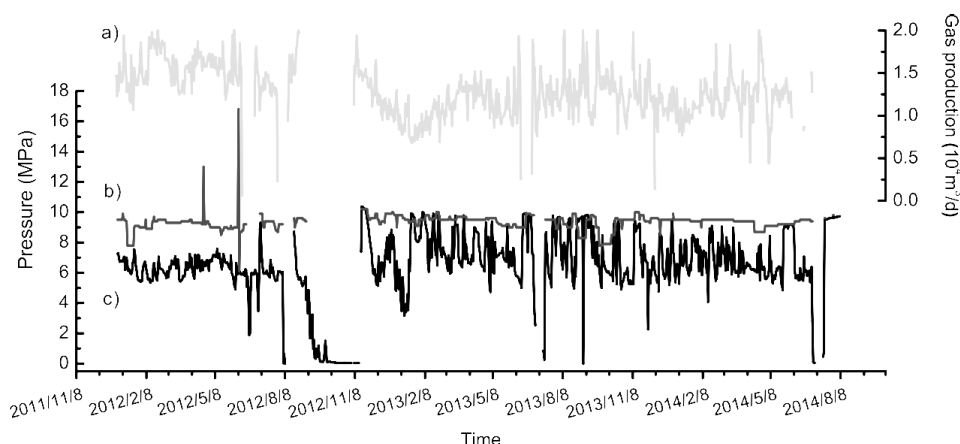


Figure 5. Production performances of the testing well: (a) gas production; (b) casing pressure and (c) tubing pressure.

Before the application of the new method, the testing well could start up for about 5 days with one-week shut-in and several times of blowout, and the gas production could hardly reach the average $0.96 \times 10^4 \text{m}^3/\text{d}$ within the start-up period, which obviously revealed the well loaded.

3.2 PERFORMANCE OF TESTING WELL AFTER APPLICATION

The new method was scheduled in the project, and we randomly took two months of the applied period for comparison.

Table 9. Comparison of well performance with and without adopting the new method.

Month	Well performance	Random stage	Before application	Increased percentage (%)
Month.1	Daily gas production	$1.13 \times 10^4 \text{m}^3/\text{d}$	$0.76 \times 10^4 \text{m}^3/\text{d}$	48.68
	Monthly gas production	$29.29 \times 10^4 \text{m}^3/\text{mon}$	$21.75 \times 10^4 \text{m}^3/\text{mon}$	34.67
	Days of start-up	28 days/month	15 days/month	
	Times of blowout	Nearly 0	3 times/week	
Month.2	Daily gas production	$1.22 \times 10^4 \text{m}^3/\text{d}$	$0.76 \times 10^4 \text{m}^3/\text{d}$	60.53
	Monthly gas production	$36.49 \times 10^4 \text{m}^3/\text{mon}$	$21.75 \times 10^4 \text{m}^3/\text{mon}$	67.77
	Frequency of start-up	No shut-in	15 days/month	
	Times of blowout	0	3 times/week	

As seen from Table 9, the testing well revived, the increased percentage of gas production exceeded 20%, and the frequency of shut-in was reduced by a large extent, which showed that the well could produce normally.

SUMMARY

1. In this study, we propose a new method of continually removing the loading liquid with periodical foamer injection manually. The costs of the new method only include the chemical agents, and it can be applied without disturbing the original pipe and wellhead apparatus, which will bring much convenience and save much time for the on-site workers.
2. The widely-used defoamers and ethylene glycol could hardly be mutually dissolvable. Thus, we proposed combining the compatible emulsifier to fix the indissolubility. The dissolvable experiment showed that the integration could be realized and the abilities remained unchanged. Admittedly, there are other possible solutions including using a new composite to replace the mixed chemical agents of ethylene glycol, defoamer, and emulsifier and equipping the new composite with anti-freezing, defoaming, and high ratio of recycling.
3. As there was no ice and hydrate during the short blowout test in the wellhead, the creation of them with outcome liquid and gas has not been tested. This cannot be experimented under the normal condition and needs special apparatus. An attention should be paid to its influence in order to guarantee the no-block in the producing string, for better application.
4. The integration of original ethylene glycol and newly injecting defoamer developed a new kind of foam drainage technology, for the severely loading or remote wells. It is of great significance to popularize this new method as primary drainage test for the gas wells without drainage technology. However, different loading wells may be sensitive to different kinds of foamers, emulsifiers, and defoamers. If the well prepares to adopt this new method, the related chemicals should be carefully selected based on the on-site conditions and expenses.

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APPENDIX

Foamer is a kind of surfactant. It could largely reduce the interfacial tension of gas-liquid interface and make the gas and liquid mixed.

UT-4 is the type of oil-defense foamer. It has good quality of biodegradability and convenience. Based on the weight percent, this foamer is made up of 50~70% Alkyl propyl betaine, 5~15% anionic surface-active agent, 10~20% hexadecyl trimethyl ammonium bromide, 5~10% sulfonate, and 5~10% water.

UT-6 is the type of frost-defense foamer. It could be used in loading gas wells in case of high temperature, high content of condensate oil, and high total solvent solid. This kind of surfactant has an outstanding effect of foaming the liquid. Based on the weight percent, this foamer

is made up of 30~50% lauryl amine oxide, 10~30% dodecyl dimethyl betaine, 0.3~0.8% polyvinylpyrrolidone, 15~25% sulfonate, 5~15% ethylene glycol, and 5~15% water.

UT-10B is the type of oil-defense foamer and could be made into solid form. It could be applied in loading gas wells with high temperature and high content of condensate oil. The liquid holdup of this foam is large. Based on the weight percent, this foamer contains 30~40% poly alkyl ether sulfate salt, 7~12% emulsion breaker, 10~15% mersolates, 10~15% ABS surfactant, 10~25% polyvinylpyrrolidone, 5~12% stabilizer, 18~26% sodium dodecyl sulphate, 12~18% methyl silicone oil, 10~18% polydimethylsiloxane, and 20~30% distilled water.

FC-117 is the type of methanol-defense foamer. It is environmentally friendly and has simple components, great effect of self-foaming, and fine stability of foam. According to the weight percent, the foamer contains 30~50% cassia essence, 10~30% polyethylene glycol, 2~8% triethanolamine, 10~30% aliphatic alcohol-polyoxyethylene ether, and 10~20% water.

UT-10A is similar to the foamer UT-10B, but it could not be applied in loading gas wells with condensate oil. The liquid holdup of this foam is large too. According to the weight percent, the foamer contains 20~30% poly alkyl ether sulfate salt, 5~10% emulsion breaker, 15~20% mersolates, 10~12% ABS surfactant, 15~20% polyvinylpyrrolidone, 15~20% stabilizer, 10~15% sodium dodecyl sulphate, 15~18% polydimethylsiloxane, and 30~40% distilled water.

CL-100 could be applied in acidgas wells with H₂S. It has great effect of anti-corrosion during the liquid foaming process. It is made up by 5-isoquinoline sodium sulfonate, xylene two chlorine, and N,N-dimethyl-N'-lauryl group-1,3-propane diamine with the mol ratios of 1.0~1.2:1.0:1.0~1.2.

Defoamer is a kind of surfactant. It could restrain the production of foam and eliminate the produced foam. There are many kinds of defoamers, such as silicone oil emulsifying and polyoxyethylene ether.

N1 is a type of frost-defense defoamer. It is easily dissolved in water and easily transported and stored. According to the weight percent, it contains 5~10% organic-siloxane, 5~10% aliphatic alcohol or aliphatic ester, 0.2~2% tackifier, 1~5% emulsifier, 0.1~0.5% antiseptic, 5~10% anti-freeze fluid, and some water.

N2 is a type of quick-defoaming surfactant. As it has 1%~2% weight percent of emulsifier SP-60; its defoaming stability has been improved significantly and the disadvantage of poor effect of joint stability and defoaming is overcome. Based on the weight percent, it contains 15%~25% Silicone Cream, 3%~5% compound emulsifier, 0.6%~1% tackifier, 1%~2% emulsifier SP-60, and some water.

N3 could be applied in loading gas wells and in drilling technology and sewage disposal. According to the weight percent, it contains 82.5%- nano-silica spheres, 14%-tackifier, 14%- emulsifier, 0.10.4%- antimold, and some deionized water. The tackifier includes carboxy methyl cellulose sodium and hydroxyethyl cellulose. The emulsifier includes the type MOA-3 and MOA-5. The antimold includes methyl alcohol.

N4 is an environment-friendly defoamer with code FG-1. It has great dissolvability, spreads quickly, and has great effect of defoaming. One sample of this defoamer contains 180~200g

methyl cyclohexane, 140~160g pentadiene, 25~30g glycidyl ether oxygen propyl alkoxy silane, 5~8g sodium carbonate, 3~5g vinyl pyridine copolymer, 5~8g Ethylene Glycol, 5~6g Glycerin Triacetate, 1~2g dioctyltin, 65~80g diglycol laurate, 5~10g hexabromocyclododecane, 5~10g silicone oil, 199~250g oxy propyl ether, 1~2g sodium benzyl naphthalene sulfonate, and 270~290g water.

N5 is the solid defoamer. It has the ability of self-regulation and could be installed directly to the gas transporting line. It also has a long shelf life. According to the weight percent, this product has 20~40% simethicone, 5~15% silicon dioxide, 10~30% emulsifier span 60, 5~15% polysorbates-80, 5~15% ethylene glycol, and 10~30% paraffin wax.

N6 is the emulsion-type defoamer. It could take effect especially against the anion foamer and non-ionic foamer. According to the weight percent, it contains 40~60% alkylate, 10~35% C4~C8-hydramine, 10~40% C10~C18-delspray, 3~8% dispersant, and some water.

Ethylene glycol is so-called glycol, 1,2-ethylidene glycol, code EG. Its chemical formula is $(\text{CH}_2\text{OH})_2$, which is the most simple diatomic alcohol. It has no color and it is in liquid form. It has fine solubility in water and acetone, but it is hard to spread in Ether. It is the raw material for solvent and anti-freeze fluid. Polyethylene glycol is also the catalyst for phase transfer.

Emulsifier is a kind of agent, which could improve the surface tension of each phase in the emulsion, making the emulsion dispersed well. It is also a kind of surfactant with hydrophilic group and lipophilic group. It could gather in the oil-water interface and reduce the interface tension.

OP-10 is a kind of emulsifier, chemical raw material. It is the condensation compound of alkylphenol and epoxyethane, which has significant effect of emulsifying, wetting, and spreading. The industrial emulsifier OP-10 is one type of the emulsifier OP series. The other types include OP-4, OP-7, OP-10, and OP-15, among which OP-10 is the most common type for application and popularization.

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