

技英语系列教程

吴松林 江淑娟

Petroleum Drilling

# 石油钻井

安丽娜 张雪梅 历冬风 © 编

石油工业出版社

科技英语系列教程

主 编 © 吴松林 江淑娟

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## 内 容 提 要

本书根据各石油院校石油工程专业英语教学实际,将英语语言能力提升与钻井专业知识学习相结合,选材上均节选自英、美等国家的国际会议论文和学术期刊,内容新颖,主要对井下设备、钻井技术和钻井材料等相关知识进行了介绍,同时涉及该领域的前沿知识和技术。

本书适用于各石油院校石油工程专业英语教学和石油钻井工作岗位操作人员培训。

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# 《石油科技英语系列教程》

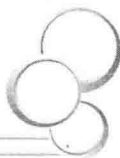
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# 前言



全球石油资源分布、生产及消费三者之间存在着严重的地区失衡,中东和亚太是失衡最严重的地区,中东地区严重供过于求,亚太地区严重供不应求。因此能源行业出现了全球化发展趋势,能源国际的交流与合作日益密切。为保证中国能源安全,中国石油和石化行业国际化和本土化发展势在必行。中国油气企业正在积极进行海外业务拓展,了解资源地区的文化背景、经济发展状况、能源开发政策并掌握其石油地质结构、油气成藏条件、开发和炼制技术等将有利于我们对资源地区的油气开发和炼制,更有力地支持中国经济的快速发展。

自1993年起,为了解决石油院校和石油职工专业英语教材的严重匮乏问题,本丛书主编陆续在黑龙江人民出版社、黑龙江科技出版社、石油工业出版社等出版了系列专业石油英语教科书,积累了一定的编写经验、培训经验和图书项目导向经验。20年过去了,石油行业也发生了巨大的变化,新油气资源不断发现,开采与炼制等技术不断更新,海外合作区域也不断拓宽。为了适应新形势,我们经过不懈努力,通过了中国石油天然气集团公司图书出版立项,开始编写一套更大规模的《石油科技英语系列教程》丛书,既包括以石油上、中、下游生产技术为主线的硬科学部分,也包括世界主要石油资源国的经济、贸易和文化等软科学部分,目的是为读者奠定通向世界石油领域话语权的语言基础。

我们深感责任重大,从中国石油大学、东北大学、东北石油大学、西安石油大学及各油田石油地质研究院、设计院等单位聘请有关专家学者,确定编写体例,搜集资料。在选材上注重内容的系统性,争取覆盖本领域主要内容;语言方面,注意遴选突出科技英语语言特点的语段和篇章,并对语言使用方法做详尽解释,以英语基础知识和基本技能的培养为主。为降低学习难度,为每篇课文还配写了汉语译文,以提高学生的石油科技英语阅读、翻译及写作能力。

《石油钻井》分册共分三个单元,分别对井下设备、钻井技术和钻井材料

等相关知识进行了介绍,在每一单元内,为了能够让学习者更好地掌握课文内容,均列出导读、相关的专业词汇及词组翻译、重点句子讲解并跟进与重点内容相关的问题。读者在回答问题的同时,可以巩固对课文的理解,进而掌握相关石油地质专业知识。为降低学习的难度,本书对文化背景中所涉及的专业词汇尽可能地作了详细的介绍。

本书的编写分工:张雪梅、历冬风编写 chapter 1 ~ 2;安丽娜编写 chapter 3。

由于作者水平有限,书中难免出现不足之处,敬请专家和读者批评指正。

丛书主编 吴松林 江淑娟

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# Chapter 1 Downhole Equipment

## 1.1 Downhole Separator Produces Less Water and More Oil

### Guidance to Reading

*Downhole oil/water separation (DOWS), as an alternative, plays an economic and beneficial role in the production of hydrocarbons. water-treating facilities.*

### Text

#### Introduction

Water management is important in the production of hydrocarbons, especially when water **volumes** steadily increase as fields age. **Novel** approaches that can reduce the water volume downhole may **supplement** the traditional approach to oil/water separation at the surface. Taking produced water out of the well stream downhole increases production-tubing and process-facility **capacity** for oil and gas. **Downhole oil/water separation (DOWS)** can reduce the need to upgrade water-treating facilities.

Downhole separation offers an alternative to **debottleneck** constrained water-handling facilities with potentially positive side-effects, such as more favorable conditions for separating oil from water, increased productivity as a result of better well **hydraulics**, reduced discharges of **oily water**, and **maintenance** of reservoir pressure. Reducing water at the source also **diminishes** the need for water treatment and for prevention of corrosion, scale, and hydrates. When wells are already pumped or when produced water is already **reinjecte**d, downhole separation will be beneficial, particularly in wells where water shutoff has proved ineffective.

New concepts for DOWS have been developed under a joint-industry project run by the Centre for Engineering Research (Canada). The **technical feasibility** of completing wells with **hydrocyclones** and downhole pumps to achieve



in-well production, separation, and reinjection was demonstrated. The first successful **installation** outside North America became operational in Germany in 1997.

### Candidate Wells

Candidate wells have a relatively low production rate (  $< 1000 \text{ m}^3/\text{d}$  ) and high water cut (  $> 95\%$  ). Wells with a risk of **sand production** or **emulsification** must be avoided. The **Eldingen field**, east of Hannover, Germany, has produced from a **shaly sand-stone** reservoir since the 1950's and meets the **screening** criteria. Well Eldingen-58 produces light oil from three **consolidated**-sand-stone intervals that are in pressure communication. The reservoir pressure is approximately 72 bar at a 1460-m **perforation** depth. Production has been lifted by a **beam pump** at  $80 \text{ m}^3/\text{d}$  with 97% to 98% water cut. **In preparation** of the DOWS installation, a packer was set to isolate the top zone from the two lower zones. The top zone was to be the producing interval and the lower zones the injection interval.

### Equipment Design

The downhole separator was designed in consultation with the equipment supplies on the basis of reservoir and well data. The DOWS for Well Eldingen-58 includes one hydrocyclone and two **electrical-submersible pumps** (ESP's). Fig. 1.1 depicts the downhole equipment and flow paths.

The high-water-cut oil flows from the production perforations upward to the top of the motor **shroud**. The bottom of the shroud is **coupled to** the pump housing by a fluid-tight seal, forcing all fluids over the top of the shroud and downward along the motor into the pump. From the **pump intake**, all fluids are pumped downward by the **total-flow pump** ( an upside-down ESP with a **thrust bearing** at the top and **discharge** at the bottom ) into the hydrocyclone where **the bulk of** the water is separated from the oil. The **underflow** of the hydrocyclone produces water clean enough for injection into the disposal zone. The overflow, oil with the **remainder** of the water, flows through bypass tubes into the **concentrate pump** for production to the surface. These three 20-m-long, 0. 9525-cm-diameter tubes that bypass the lower pump and motor are sized so that erosion and pressure drop are minimal.

A common motor drives both pumps. This motor has **protectors** at top and bottom, unlike a normal ESP. The motor is powered from the **variable-speed**

**drive** at the surface through a flat cable, which is strapped to the tubing with metal bands and **cross-coupling** protectors. With a variable-speed drive and an adjustable surface choke, the system can cover the expected variability in injectivity and productivity.

The pump design **depends on** the flows and pressures required to lift the oil-rich stream compared with those needed to reinject the water. The push-through system used in Well Eldingen-58 is most efficient for dealing with the low reservoir pressure in Eldingen. This concept also avoids any breakout of gas in the hydrocyclone. If the reservoir pressure is sufficiently high, a concentrate pump is not needed. Alternatively, the well stream may be separated before being pumped; this so-called pull-through concept can be applied provided the **bubble point pressure** is high enough to prevent gas breakout in the hydrocyclone. In some crude oils, the latter concept would avoid **emulsions** and poor injection-water quality as observed in earlier DOWS trials with heavy oil.

Solids carried by the separated water are the biggest concern for sustained injectivity. However, the consolidated reservoir in Eldingen has little sand production. For efficient oil/water separation, the split between overflow and underflow of the hydrocyclone can be controlled by chokes. The oil-in-water content in the underflow of the hydrocyclone should be 100 to 300 ppm. To ensure this water quality into the disposal zone, a **rule of thumb** for DOWS is to keep the surface water cuts lightly higher than 50%. The separation efficiency depends largely on characteristics of the oil/water mixture, in particular oil droplet size. Knowledge of the droplet-size distribution in oil-in-water emulsions downhole could enable better separation.

### Technology Outlook

Well re-entry has not been required for corrective action on downhole e-

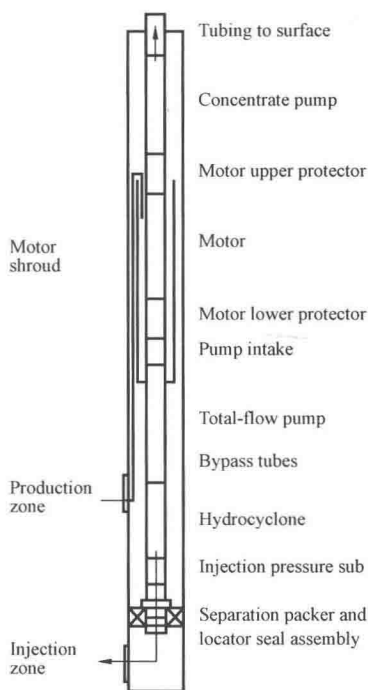


Fig. 1.1 Downhole equipment lineup of well completion and flow paths for Eldingen - 58

quipment. The water is injected under matrix-flow conditions, and no sign of permeability damage has been observed. Adjacent wells have experienced an increase in fluid level and water cut. These trends result primarily from the influence of DOWS because these wells produce from the lower zones into which Well Eldingen-58 is injecting. Despite favorable performance, the economics of DOWS is still relatively poor. Assuming U. S. \$ 15/bbl and a production-rate increase of 30 B/D, payback time is approximately 1 year. Important factors include oil price, process-facility capacity, and an increase in tubing oil-flow capacity. Phasing well conversions **in accord with** increasing water rates also would limit exposure of large up-front investments. The concept, developed originally for debottlenecking production facilities, is being upgraded with a more efficient downhole separator **aimed at** reducing the infrastructure and facilities for offshore fields.

### Conclusions

Industry still needs to prove that down-hole separation is a reliable, cost-effective means to increase oil production from capacity-constrained facilities, potentially lengthening the life of oil fields.

The downhole-separation concept, developed originally for debottlenecking onshore facilities, has the potential to reduce the **infrastructure** and facilities of offshore oil fields.

Evidence exists that water, separated downhole, can be injected under matrixflow conditions, which may lead to significant power savings in water-injection systems if sustained.

Water-cut development in the Eldingen field indicates that DOWS should be applied in reservoir configurations with flow barriers between producing and injection intervals.

### □ Words and Expressions

volumes	体积, 容量 (volume 复数); 卷
novel	新奇的; 异常的
supplement	补充, 补遗; 补充物; 附录
treating	[化工] 处理 (treat 的 ing 形式); 对待
debottleneck	去瓶颈; 排除故障; 消除薄弱环节
hydraulics	水力学

oily water	油污水; [油气]混油水
maintenance	维护, 维修; 保持; 生活费用 (maintain 的名词形式)
diminish	使减少; 使变小
reinject	再注入; 再注射
technical feasibility	技术可行性
hydrocyclone	水力旋流器
installation	安装, 装置; 就职
sand production	出砂
emulsification	[化学]乳化; [化学]乳化作用; 乳化剂
screening	筛选; 拍摄 (screen 的 ing 形式); 遮蔽; 隔挡
consolidated	合并; 巩固 (consolidate 的过去分词形式); 统一
perforation	穿孔; 贯穿
beam pump	摇臂泵
shroud	寿衣; 覆盖物; 船的横桅索; [电]护罩
discharge	[环境]排放; 卸货; [流]流出
underflow	[水文]底流; [计]下溢
remainder	[数]余数, 残余; 剩余物; 其余的人
protectors	保护者; 保护装置 (protector 的复数)
cross-coupling	交叉耦合; 交互耦合
emulsions	乳剂; 感光乳剂; 乳胶 (emulsion 的复数)
B/D	(bbl per day) 桶每日
infrastructure	基础设施; 公共建设; 下部构造

## Phrases and Expressions

capacity for	……的能力
in preparation	在准备中
be coupled to	与……耦合
the bulk of	大多数, 大部分
depend on	依赖于, 取决于

in accord with  
aimed at

同……相符合,与……一致  
针对;目的在于

### Proper Names

Downhole oil/water separation (DOWS)	井下油水分离
Eldingen field	埃尔丁根油田
shaly sand-stone	泥质砂岩
electrical-submersible pumps (ESPs)	电潜泵
pump intake	[机]泵吸入口
total-flow pump	总流泵
thrust bearing	[机]推力轴承; [机]止推轴承
concentrate pump	泡沫原液泵
variable-speed drive	[机械工程] 无级变速传动
bubble point pressure	泡点压力
a rule of thumb	经验法则

### Language Focus

1. Downhole separation offers an alternative to debottleneck constrained water-handling facilities with potentially positive side-effects, such as more favorable conditions for separating oil from water, increased productivity as a result of better well hydraulics, reduced discharges of oily water, and maintenance of reservoir pressure.

(参考译文:井下分离器为从正面解决水处理设备的瓶颈问题提供了替代方法,如提高了生产能力,从水中分离油具有了更适宜的条件,从而减少了含油污水的产出,保持了储层压力。)

本句中主干为 Downhole separation offers an alternative to debottleneck, constrained 为非谓语动词做后置定语,修饰 debottleneck。such as 后为举例说明 side-effects, 其中 increased 和 reduced 为非谓语动词作定语。

2. When wells are already pumped or when produced water is already reinjected, downhole separation will be beneficial, particularly in wells where water shutoff has proved ineffective.

(参考译文:当井已用泵抽油或当产出水已进行回注时,尤其是在堵水

已被证明是无效的井中,井下分离器将是经济有效的。)

本句的主干是 downhole separation will be beneficial. when... or... when... 是有 when 引导的并列时间状语。particularly in wells where water shutoff has proved ineffective 作地点状语,其中 where 引导定语从句,修饰 wells。

3. These three 20-m-long, 0.9525-cm-diameter tubes that bypass the lower pump and motor are sized so that erosion and pressure drop are minimal.

(参考译文:绕过下部泵和马达的3个油管被确定为20m长、0.9525cm的直径,以便将腐蚀和压降控制到最小。)

本句的主干是 These three 20-m-long, 0.9525-cm-diameter tubes are sized, that 引导定语从句修饰 tubes。so that 引导目的状语从句。

4. The pump design depends on the flows and pressures required to lift the oil-rich stream compared with those needed to reinject the water.

(参考译文:根据流量以及把举升富含油液所需的压力与回注水所需的压力进行比较,可设计出泵。)

本句中 The pump design depends on the flows and pressures 是主句; required... 为非谓语动词作后置定语,修饰 flows and pressures。compared with those... 为非谓语动词作状语,其中 those 指代 flows and pressures。

5. this so-called pull-through concept can be applied provided the bubble point pressure is high enough to prevent gas breakout in the hydrocyclone.

(参考译文:在泡点压力足够高时,这个理念能够防止水力旋流器中的气爆。)

本句主干为 this so-called pull-through concept can be applied。provided 引导条件状语从句,译为:假如,倘若。

## Reinforced Learning

### I. Answer the following questions for a comprehension of the text.

1. What is the function of DOWS?
2. What are the criteria of selecting candidate wells?
3. Why are these tubes that bypass the lower pump and motor sized?
4. What are the advantages of the push-through system used in Well Eldingen-58?
5. What are the biggest concern for sustained injectivity?

**II. Multiple choice: choose the correct one from the alternative answers to give the exact meaning of the words.**

1. Protesters found a novel way of demonstrating against steeply rising oil prices.

- A. story                      B. new                      C. fiction                      D. wrong

2. Police say they're treating it as a case of attempted murder.

- A. considering      B. working      C. watching      D. handling

3. He never put her down or diminished her.

- A. decreased                      B. looked down upon  
C. discovered                      D. cheated on

4. Mankind have been trying every means to maintain the balance of nature.

- A. keep                      B. contain                      C. attain                      D. captain

5. They had installed a new phone line in the apartment.

- A. fixed                      B. named                      C. used                      D. placed

6. Our country has an enviable record on breast screening for cancer.

- A. shooting      B. searching      C. checking      D. projecting

7. The two banks in this city will consolidate and form a single large bank.

- A. separate      B. reinforce      C. cooperate      D. unify

8. He gulped down the remainder of his coffee.

- A. left                      B. surplus                      C. recalling                      D. maintenance

9. Then they create new and better infrastructure, as and when they need it.

- A. basic facilities                      B. environment  
C. house                      D. basement

10. The bulk of the funds are supplied by some of America's largest and most powerful corporations.

- A. majority                      B. minority  
C. mass                      D. number

**III. Multiple choice: read the four suggested translations and choose the best answer.**

1. When egg whites are beaten they can rise to seven or eight times their original volume.

- A. 卷                      B. 量                      C. 体积                      D. 版本

2. Business sponsorship must be a supplement to, not a substitute for, public

funding.

- A. 补充      B. 增刊      C. 额外费用      D. 附录

3. By identifying the bottleneck, you identify which resource is limited.

- A. 瓶颈      B. 商标      C. 现状      D. 测井

4. The government plans to make absent fathers pay maintenance for their children.

- A. 医药费      B. 学费      C. 维修费      D. 抚养费

5. We now need to test these results in larger studies to find if this could lead to a potential screening method for the disease.

- A. 遮蔽      B. 筛选      C. 放映      D. 阻止

#### IV. Put the following sentences into Chinese.

1. Taking produced water out of the well stream downhole increases production-tubing and process-facility capacity for oil and gas.

2. The top zone was to be the producing interval and the lower zones the injection interval.

3. The bottom of the shroud is coupled to the pump housing by a fluid-tight seal, forcing all fluids over the top of the shroud and downward along the motor into the pump.

4. Solids carried by the separated water are the biggest concern for sustained injectivity.

5. The separation efficiency depends largely on characteristics of the oil/water mixture, in particular oil droplet size.

#### V. Put the following paragraphs into Chinese.

1. Recompleting the well has increased net oil production by 300%, while net water production to surface has decreased by 64%. In the first year of operation, reinjection of water, separated downhole, did not damage matrix permeability; however, a water-cut increase was observed in the project area.

2. The downhole oil-water separator is the core part of the downhole oil-water separation system. On the basis of the structural configuration of the traditional static hydrocyclone, a new downhole oil-water separator is developed. The prototype test verifies the separation efficiency of the new separator. And the test data shows that the separator can satisfy the requirement of downhole oil-water separation.



## 1.2 Maximizing Production with Permanent Downhole Sensors

### Guidance to Reading

*Permanent continuous downhole sensors enhance reservoir management, optimization, and development. Efficient data management and analysis allow operators to exploit the technology and extract more value from production data. Downhole sensors for scale and sand detection and advances in fiber-optic technology can enhance real-time knowledge of dynamic reservoir conditions.*

### Text

#### Introduction

Permanent continuous downhole **reservoir-monitoring systems** have been run in only a few wells. Cost, reliability, risk, environmental limitations, **arduous** data-evaluation processes, and **lack of** awareness have limited wide-spread use of these technologies. New technologies for **deployment** and for data management and interpretation are making well monitoring more feasible. Significant improvements have been made in extracting the value from the acquired data **as well as** improving reliability and reducing environmental limitations.

#### Sensor Technologies

Primarily, **sensors** are used for measuring downhole pressure and temperature. New sensors are being developed to measure other physical **parameters** of the downhole environment. Sensors are either electronic or nonelectronic. Recent advances have yielded smaller, less-expensive, and more-reliable systems with higher temperature and pressure ratings.

*Electronic Systems.* Most downhole pressure and temperature systems are electronic systems. Early electronic systems used **strain-gauge** technology for pressure measurement, which has limited resolution and inherent drift problems. Current downhole-pressure-measurement sensors use resonating-quartz technology where the inverse piezoelectric effect induces vibration in the resonator at its mechanical resonant frequency. This technology provides high accuracy and **resolution**.

New manufacturing processes have improved both the reliability and **rug-**