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ПОЛУЧЕНИЕ ДАННЫХ И МЕНЕДЖМЕНТ

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DATA ACQUISITION AND MANAGEMENT

Введение

Сбор и использование данных о месторождении очень важны для любой нефтегазовой компании, чтобы обеспечить необходимую добычу требуемого качества. Разработка месторождения требует глубоких знаний о залежи, что может быть достигнуто только путем регулярного сбора, обработки и интеграции базовых данных о его характеристиках в течение всего срока службы.

Производственникам хорошо известно, что примерно через год добыча сокращается вследствие определенных факторов. Некоторые основные факторы остаются неизвестными, если не производится наблюдение за скважинами.

Цели и задачи

Обосновать эффективность системы управления данными.

Проанализировать ключевые вопросы:

- описание системы управления данными;
- методы и технические способы сбора данных о месторождении.

Результаты

Сбор данных и их применение очень важны для компаний, работающих в нефтегазовой отрасли, для добычи продукции требуемого качества в течение длительного времени на основе решения проблем, возникающих по мере разработки месторождения в связи с понижением пластового давления, коррозией, эрозией и т.д.

Background

Data acquisition and management from the reservoir is very important for any oil and gas company to ensure that the desired production at the desired quality and quantity is happening. Reservoir management requires a deep knowledge of the reservoir that can be achieved only through gathering its characteristics over its entire life on a regular basis by a robust process of acquiring, processing and integrating several basic data.

Operators always find the production reduced after a year or so due to several factors. Some of the major factors remain unknown if the wells are conventional type without any feedback mechanism.

Aims and Objectives

Present the effectiveness of the data management system.

Analyze key areas:

- description of data acquisition;
- ways and technical methods for gather reservoir data.

Results

Data acquisition and management are very important for oil and gas operating companies to keep reasonably quality production for a longer time by providing solutions to the issues being faced with the depleting reservoir pressure, corrosion and erosion, etc.

Результаты

Сбор данных и их применение очень важны для компаний, работающих в нефтегазовой отрасли, для добычи продукции требуемого качества в течение длительного времени на основе решения проблем, возникающих по мере разработки месторождения в связи с понижением пластового давления, коррозией, эрозией и т.д. С помощью таких интеллектуальных систем, как MPFM/WGV/SWC/PDHMS и других специалисты по эксплуатации способны обеспечивать добычу продукции на месторождении более длительно.

Собранные данные не должны игнорироваться, их необходимо тщательно анализировать и использовать. С целью обеспечения стабильного качества продукции необходимы достаточные капитальные и эксплуатационные расходы на заключение с поставщиками интеллектуальных систем регулярных ежегодных контрактов на техническое обслуживание.

Результаты обследований скважин на морских платформах приносят много пользы. Специалисты по эксплуатации получают массу информации, с помощью которой они могут добиться максимальной добычи продукции, сократить объемы попутной воды, сократить объемы газа, используемого для процесса газлифта, сократить ручное вмешательство, сократить риски, связанные с морской средой и т.д.

Капитальные затраты, очевидно, будут выше по сравнению с традиционной конфигурацией, однако в долгосрочной перспективе преимущества будут значительными. Данные по замерам давления и температуры, а также расхода дадут возможность операторам, находящимся в удаленной диспетчерской, эффективнее управлять процессом добычи и получать огромные выгоды от капитальных вложений.

Results

Data acquisition and management are very important for oil and gas operating companies to keep reasonably quality production for a longer time by providing solutions to the issues being faced with the depleting reservoir pressure, corrosion and erosion, etc. A strong team of operation and technologists with back-up from the suppliers of the intelligent systems like MPFM/WGV/SWC/PDHMS etc. can go a long way to keep the production 'on' for longer periods.

Data gathered must be diligently analyzed and used and not wasted or ignored. Adequate CAPEX and OPEX shall be provided to ensure intelligent systems are available on the facility and regular annual maintenance contract is made with the systems suppliers to ensure sustained quality production.

Intelligence added to the wells in offshore platforms do a lot of wonder. Operators get equipped with loads of information with which they can maximize the production, cut down on the water production, cut down on the volume of gas being used for gas lift process, reduce manual intervention, cut down on the risks involved in an offshore environment, etc. The CAPEX will obviously be higher compared to a traditional configuration, however, the benefits are aplenty in the long run. Combined with pressure and temperature measurement, the flow measurement will help the operators sitting in a remote control room to manage their assets still better and reap huge benefits on the CAPEX.

Ключевые слова: скважина, геофизические и геологические данные, получение данных и менеджмент, способы сбора данных, давление, датчик

Key words: well, geophysical and geological data, data acquisition and management, ways to gather reservoir data, pressure, sensor

Objective

The demand for Oil and Gas at present is very huge across the globe. The forecast is that this demand is going to shoot-up only and it would be a huge burden on the Oil & Gas Operators to produce more and meet the demand.

Oil & Gas reserves are depleting at conventional water depths and need deep digging. However, it is not prudent for deep digging since the Oil & Gas reservoir owners need to know multiple parameters about the reserves available to make a reasonably profitable business for a longer duration.

The recovery is only around 35 % worldwide. Sophisticated Enhanced Oil Recovery (EOR) and Improved Oil Recovery (IOR) methods are being employed in many fields but the recovery is still not satisfactory.

Data acquisition and management from the reservoir is very important for any Oil and Gas Company to ensure that the desired production at the desired quality and quantity is happening [1-5].

Reservoir management requires a deep knowledge of the reservoir that can be achieved only through gathering its characteristics over its entire life on a regular basis by a robust process of acquiring, processing and integrating several basic data.

Operators always find the production reduced after a year or so due to several factors. Some of the major factors remain unknown if the wells are conventional type without any feedback mechanism.

What is Data Acquisition?

Data acquisition is to collect various process, geophysical and geological data from the reservoir through various established methods to gather information using intelligent sensors and process them at the system end and make relevant conclusions about the reservoir behavior, production rates and assess life of the reservoir for further production.

Geophysical, geological, and engineering characterization provides information on the initial distribution of the fluids, as well as on the hydraulic connectivity between different zones of the reservoir rocks.

An efficient data management program for collecting, analyzing, storing and retrieving them is, therefore, required for good reservoir management.

An efficient data management system is, hence, a key issue for storing and retrieving raw and processed data into a readily accessible form.

The amount of acquired data can vary based on:

- *Size of the database;*
- *Size and type of the resource.*

Moreover, the acquisition and interpretation of the data requires a robust quality assurance process for their validation and correct interpretation.

Ways to Gather Reservoir Data

There are various ways to gather reservoir data in an efficient manner. There are many sophisticated methods to gather relevant and reliable data regarding the reservoir behavior. Following are the methods which most of the Oil & Gas Operators use on their fields:

- Pressure and temperature measurement and controls using Permanent Down Hole Management System (PDHMS);
- Smart Well Completion (SWC) method using electronic and hydraulic circuits;
- Multiphase flow metering on top-side using Multi Phase Flow Metering (MPFM) or Wet Gas Venturi (WGV) depending upon the Gas Volume Fraction (GVF);
- Monitor and assess the monthly production of oil and gas;
- Conventional and special core analysis.

The reservoir behavior depends hugely on the geological, geophysical and fluid character. These characters impact the fluid distribution and the hydraulic connectivity between the fluids reserve in various zones of the reservoir.

Data gathering method cannot be consistent for all the reservoirs. It needs to be decided depending upon the fluid properties, depth of the reservoir, commercial feasibility etc.

Detailed Description on the various ways to gather data

- *PDHMS*

PDHMS uses special pressure and temperature sensors on the production well-conductors across the Down Hole Safety Valve (DHSV) to detect the pressure and temperature gradient. The gradient readings inform the Oper-

ator that there is a damage to the conductor in terms of leak due to a crack or corrosion. The higher the gradient, the higher is the damage. Special resonating quartz crystal sensors are used to measure pressure and temperature at the downhole. Resonating frequency of the electrically excited crystals provide the readings.

Refer to Figure 1. The sensors are located on the production conductor (or tubing) for example, across.

Electric Submersible Pump (ESP) used to raise the reservoir pressure. The gradients help understand the reservoir behavior, conductor health, etc. Special pressure and temperature sensors are employed for the purpose unlike the ones used on top-side. Example is Halliburton Data Sphere SmartLog ROC (Figure 2) which provides reliable data on pressure and temperature on the production fluid flowing through the conductor. The data are real-time and thus help Operators assess the reservoir health, production rates, etc. PDHMS gather the data for assessment and transmission to Control system. Multi-drop technology can be used between multiple sensors located at various zones on the conducting tube.

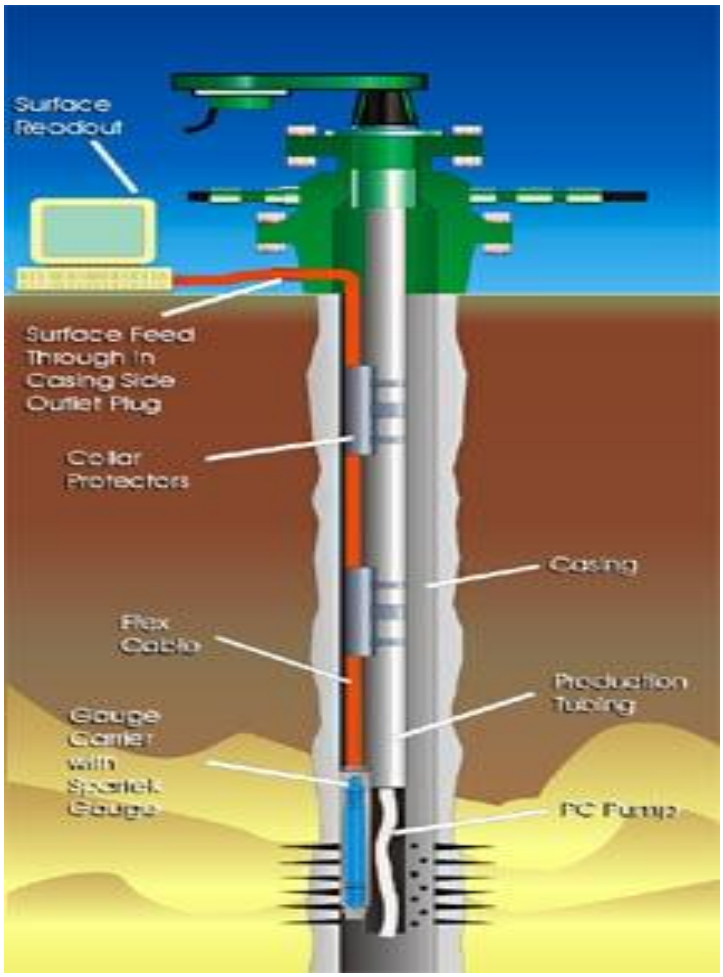

Figure 1. PDHMS Loop in a production tube (Courtesy: Spartek Systems)

Figure 2. Halliburton Data Sphere ROC Sensor

The gauge provides hermetically sealed protection against ingress of solid and liquids and at the same time, can withstand very high pressure, up to 25000 psig as per Halliburton technical bulletin.

The sensors provide analog signals which are used at the PDHMS control system to assess and provide reservoir behavior report. The system can be hooked-up to the field Control System (DCS) via serial link for data acquisition, graphics display and further assessment.

Drilling expert companies like Halliburton, Schlumberger, FMC etc. have their intelligent sensors and systems for the purpose. PDHMS aids the reservoir engineers in calculating real-time productivity indices for each lateral leg and performing pressure build-up tests without well intervention. This information is used to maximize the production from each leg, maximize the drawdown, maximize the efficiency of ESP (Electric Submersible Pump) and update the reservoir model.

• *SWC*

SWC is similar to PDHMS except that it has hydraulic loops in addition to electronics. The Control System monitors and controls Interval Control Valves (ICVs) using hydraulic pressure. ICV is also called production regulator, refer Figures 3-5.

Figure 3. Interval Control Valve (Courtesy: Halliburton)

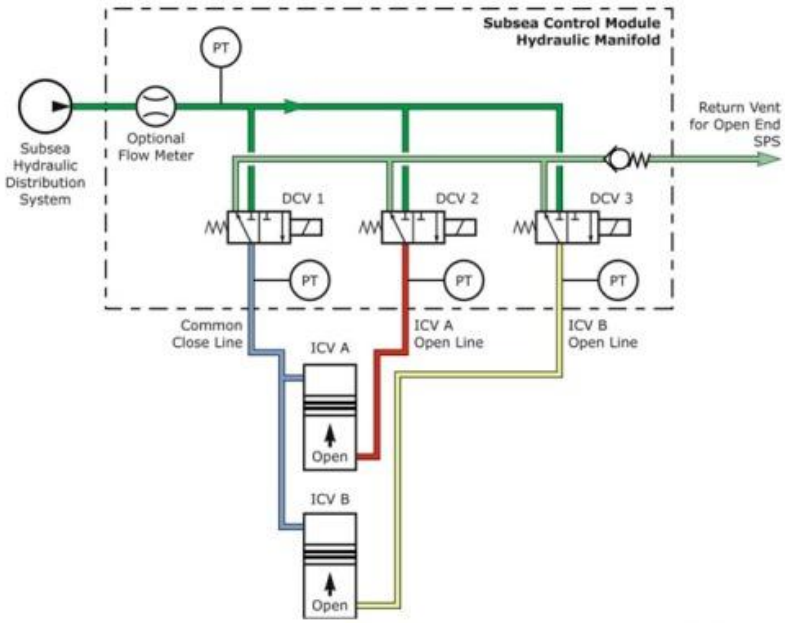

Figure 4. SWC Block Diagram

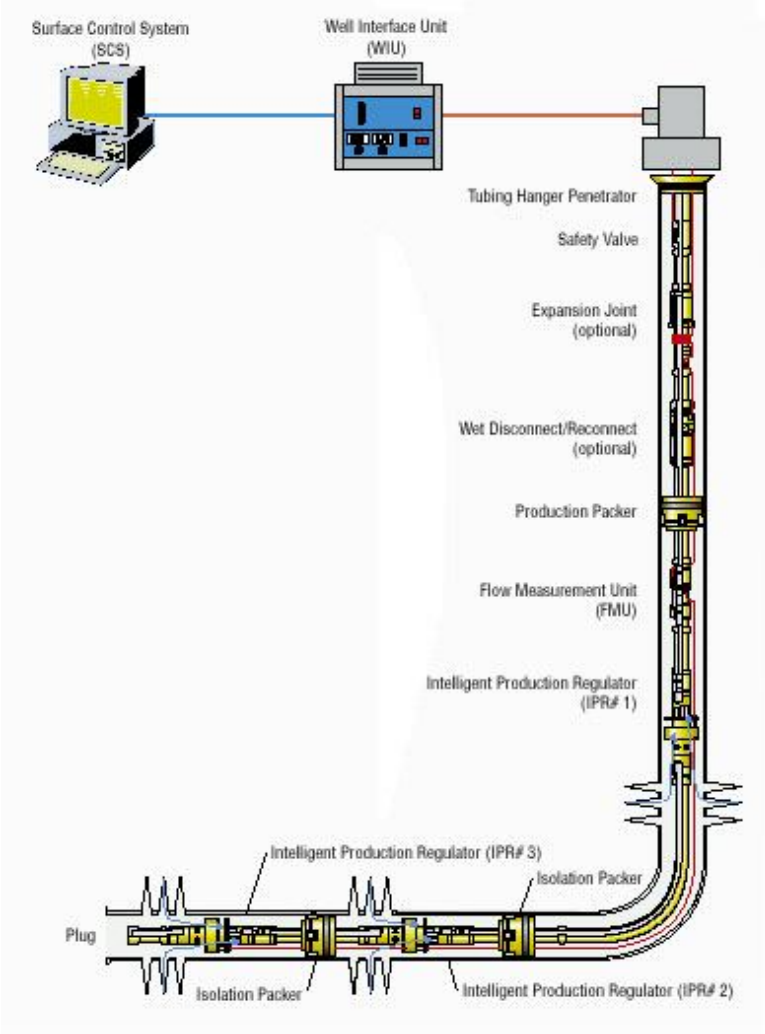

Figure 5. SWC scheme (Courtesy: Baker Oil Tools website)

Operators like Saudi Aramco, Maersk (Total) use SWC for reservoir management on all their remote wellheads and is being found really useful. Regular assessment of the data from the system and action using them will surely help efficient reservoir management.

SWC scheme will provide a lot of information to the Operator – production profile, watercut, oil and gas production rates, etc. SWC helps on water or gas shut-off on daily basis. Detection of water could be done using the pressure and temperature sensors at the ICV.

Installation of ICVs on lateral wells helped Saudi Aramco to sustain production rate of 1.5 MBD even after 6 years. Intelligence also helped Saudi Aramco to optimize on the number of wells to be drilled and thus brought down cost.

With sophisticated electric-fiber optic hybrid system for pressure and temperature measurement in various zones of a multi-lateral wells, Operators can rely upon the data to take firm decisions regarding the reservoir management. Dubai Petroleum Corporation uses the temperature profile for adjusting the gas lift process for various wells. This prevents the lengthy process of wire-line operation to gather information before gas lift.

ICVs are coming with numerous positions to place and this gives flexibility to the Operators to control water injection and gas lift processes.

• *MPFM/WGV*

Multi-Phase Flow Meter (MPFM) on topside provides important data regarding the reservoir production profile and reservoir behavior (Figure 6). The measurement available from MPFM at a remote Control Room helps to know the pressure, temperature, production profile, flow rates, water cut etc. If sand monitoring system is available on the facility, it can be hooked to the MPFM/WGV system to gather information on the sand production and refine the readings. These readings help the Operators decide on various steps to choke the production, thus control the water and sand production, etc.

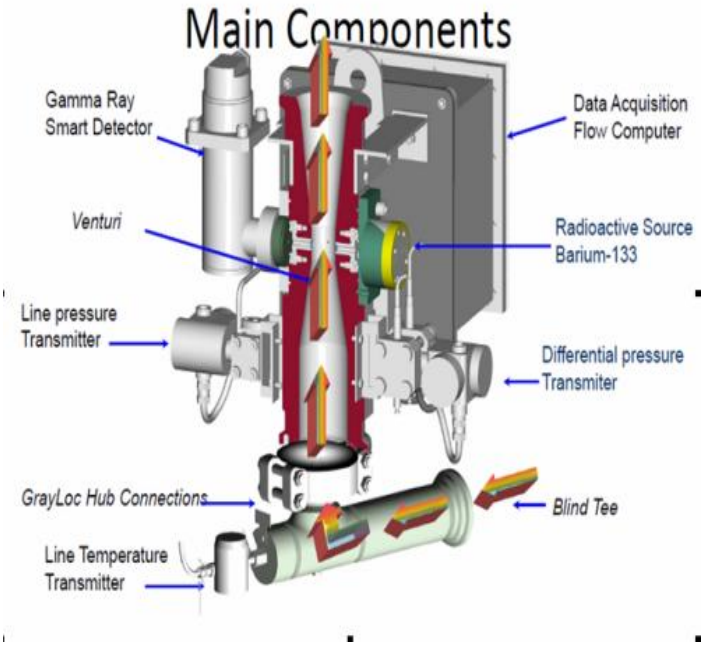

Figure 6. MPFM Instrumentation (Courtesy: Bela Liptak article in Control Magazine)

If the Gas Volume Fraction (GVF) is more than 95%, a Wet Gas Venturi (WGV) scheme is used on the flow lines to gather fractions for gas, condensate and water being produced from each string. These readings help the Operators to assess the reservoir production and take necessary action.

• *Assessment of Monthly Oil & Gas Production Rates*

Reservoir behavior is always erratic and is difficult to fathom. It is very difficult to predict reservoir behavior due to numerous factors. The production profile would be healthy in the initial years of the platform but start drooling as the years go by. This results in frequent shutdown, loss of production, quality and so on.

Monthly assessment of the production rates by the Operation team is a standard practice with any Oil & Gas Company. The data is available in the Control system which are logged on daily basis and provide results at the end of every month in an appropriate tabular form for easy reading and assessment. The production rates, the fractions of each phase (gas, condensate and water), quantity of sand (via sand monitoring system, if installed), etc. help assess the reservoir behavior and take appropriate mitigation steps to maintain the production to the satisfaction of the Company and the Stake Holders.

The data shall be assessed by the Technical, Operating and Management together to take effective and feasible mitigation steps for the reservoir issues. Refer to Figure 7 for the team composition that would surely help in effective reservoir management. Many times, following are found to be the hurdles on such an effective team management:

- frequent changes to the team composition;
- frequent changes in the priorities with the team members;
- data gathered insufficient and irrelevant;
- lack of documentation to assess the data and arrive at any effective solution.

Gathering data on the production rates is not adequate and meaningful if they are not properly and regularly assessed and actions taken when need to.

Many times, Operating team take bypass routes to run the plant to keep up the production, instead of attending to the existing problems which can provide more production and controls on the day-to-day problems. Making these assessments on a systematic, regular basis can be more effective in developing a common strategy that improves communication and in ensuring a comprehensive review and a more complete listing of improvement opportunities.

Reservoir management assessments are also effective in providing a comparison with ideal or best practices that result in a more innovative environment and in establishing a method of documentation and measurement to determine how well reservoir management is being sustained despite changes in personnel and priorities.

Figure 7. Team to Assess Reservoir Data

• *Core Analysis*

A technology called Core Analysis is seemingly been used by most of the Operators to analyze a reservoir by studying the petrophysical properties of the rocks in the reservoir. This analysis is not easy but it provides lot of useful information if performed correctly. Oil and Gas well coring are carried out by the drilling team to analyze the rock samples to find out the quality and quantity of reserves available in a reservoir. Simple rock analysis and special core analysis (SCAL) are carried out to find data.

The SCAL helps the drilling group gather the following data:

- petrophysical properties of the rock when fluids are present in it;
- displacement efficiency of the rock when enhanced or improved oil recovery method is employed (EOR/IOR);
- what happens to the rock porosity and permeability when reservoir pressure reduces, in terms of fluids oozing out.

Petrophysical properties of rocks beneath the sea include porosity, capability to hold water,

lithology (study of grain size, composition, texture etc.), permeability etc. Well log tools (e.g. wire line tool, LWD i.e. Logging While Drilling where tools are inserted along the drilling tool for study purpose) are used to gather information about the rocks and logged as 'well log' for further study. For well log information, either rock sample is used or tool is lowered into the reservoir for gathering information.

Reservoir models are built upon their measured and derived properties to estimate the amount of hydrocarbon present in the reservoir, the rate at which that hydrocarbon can be produced to the Earth's surface through wellbores and the fluid flow in rocks.

In Figure 8, well-log report shows the petrophysical properties as follows:

- Based on gamma ray irradiation, pores and grain size are evaluated of a rock sample. Yellow portion in the first track shows that less gamma rays have been radiated and hence they are small grained and more porous;
- Second track shows the depth of the rock in the sea-bed;
- The third track shows the electric resistivity – more conductivity is observed due to the presence of salty water. This means rock pores are filled with more of water and less of hydrocarbons;
- 4^{th} and 5^{th} tracks show the amount of fluids present in the rock pores – green colored shows the presence of hydrocarbon and the blue, the water.

Core analysis is not easy and expensive though very informative about the rocks that are beneath the sea bed and store the hydrocarbon fluid.

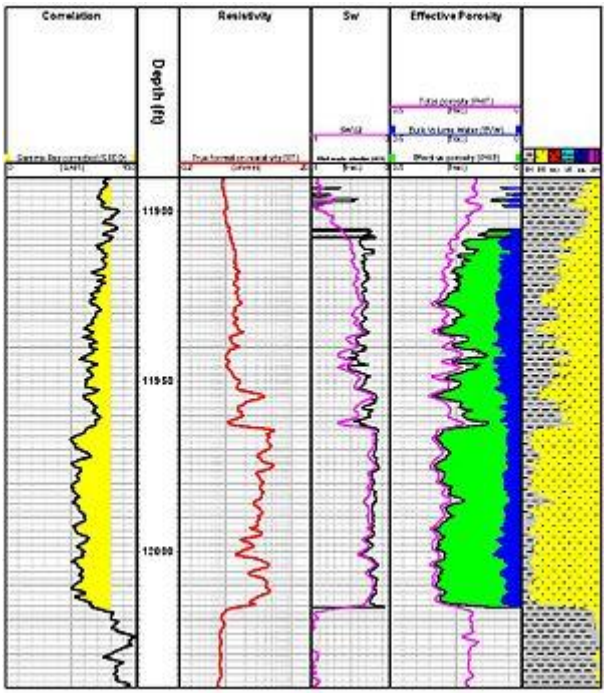

Figure 8. Core Analysis – gathered via wire line tool (example gathered from Wikipedia)

Conclusion

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suppliers of the intelligent systems like MPFM/WGV/SWC/PDHMS etc. can go a long way to keep the production 'on' for longer periods.

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