A Stepwise Approach To Lease Automation

By H. S. DOZIER and R. A. MORGEN
Black, Sivalls & Bryson, Incorporated

ABSTRACT

Automating of oil production leases may be approached stepwise if proper planning is done initially. This paper summarizes the various automated processes in lease production, showing the limits and planning required. A hypothetical lease is studied and the equipment required to automate at each stage is set out.

INTRODUCTION

In order to proceed toward the objective of this discussion, lease automation is defined as the interconnection of several automatic or semiautomatic processes into a comprehensive overall system to improve the efficiency of lease operation.

It is the opinion of the writers, and also of many but certainly not all system designers, that in lease automation each process should operate completely and independently within itself except for its interaction on other processes in the overall system. This basic philosophy is essential to effecting a stepwise approach to lease automation and will apply throughout this discussion.

Technology has progressed to a degree that all processing on a lease can be integrated into a lease automation system. It is the purpose of this paper to discuss these lease processes, which concern fluid handling, and how each can be automated in a stepwise fashion.

LEASE PROCESSES

The fluid handling processes from the wellhead to the pipeline consist basically of the following:

1. Well flow control
2. Fluid routing
3. Fluid processing
4. Delivery to pipeline
5. Data gathering

Note that the processes as defined do not require duplicating operations but instead each is set out to obtain a desired end result. Around the philosophy that each process be self controlled it is possible to approach lease automation — stepwise!

A further examination of each process, defined above, will locate the functions that must be performed.

Well Flow Control

Well flow control can be defined as the supervision of the productivity of a well and may be done for a variety of reasons. Two of these might be: ON-OFF or INTERMITTING control to prevent well from "pumping off" or to produce efficiently according to the particular well's characteristics; FLOW PROGRAMMING for electrical load balancing or for proration reasons. These and other methods have been used on an automatic or semiautomatic basis for a number of years. As such, Well flow control can be said to be a well established unit operation; however, these operations usually are on a per well basis, i. e., the programming clock is located at the wellhead or pumping unit.

A central programming system for a number of wells offers several advantages. Two of these are: the well programs are more easily changed and synchronized and the status of each well is more easily determined.

Fluid Routing

In this category are grouped well testing and the subsequent return of fluids to the proper points within the system to allow most efficient processing and proper accounting.

Well testing encompasses the routing of the fluid to the proper test apparatus; the measurement of quantity and quality; the accumulation of the test data.

Data may be accumulated in many ways, a few of which follow.

1. Local readout counters
2. Strip chart recorders (operational and analog)
3. Local printing or punch equipment
4. Electrically stored for later transmission to a central location

Note that these forms are listed pretty much in the order in which they have been applied to lease automation. Also, note that they progressively require less operator attention.

At the conclusion of these operations, the fluids must be properly routed to a particular process. From a control standpoint this single factor varies more than any other from lease to lease.

As an example, where Kobe production is used it is usually necessary, when testing a well, to subtract the oil used by the Kobe pumps from the total oil measured during the test. It is also required to return oil to the "Kobe Power Oil Tank" in order for the process to continue.

Another problem commonly encountered is the separation of "wet" and "dry" wells in order that the fluids from each get the best processing attention.

Accounting requirements may also dictate the method by which fluids are handled.

Economically it is desirable to use only one test system regardless of special processing requirements. Therefore, in an automatic system, special attention must be given to routing the fluids to the desired destination.

Fluid Processing

The entire purpose of any lease production unit can easily be reduced to one description: The processing of the fluids to salable products. To insure that each piece of process equipment does its particular job many control problems must be solved. Since the purpose of the paper is to look at the overall system, examination of specific equipment will be confined to only a few and only from a general viewpoint.

Separation equipment exists on every lease production unit. From a system standpoint, the separator is of primary interest only with reference to its effect on other components of the system. It is well at this point to review

the philosophy set out in the introduction — each unit within an overall system must be able to independently control its own process.

In other words, the separator must be designed to properly separate the oil and gas and to properly control its fluid level. From a system viewpoint, however, it must in addition not impair the operation of any other unit in the system due to its own failure to perform its functions. This usually means that provisions must be made to guard against high or low fluid levels. The placement of float or displacement level controls to limit the rise and fall of the fluid is by far the most widely used method to accomplish this.

In emulsion treaters similar monitoring must be accomplished. With this equipment it is common to monitor for high and low temperatures as well and often reasonable to monitor for excessive water in the treated oil.

In automatic water filtering systems it is common to monitor for high differential pressure across the filter(s) and for sufficient water level in storage or surge tanks to maintain NPSH on the pumps or to complete a backwash.

These are only a few of the automatic features of certain process equipment. For each to be integrated into an overall system it is only necessary to make plans for the equipment to perform its own function and to provide alarm or monitoring devices to signal when it has failed to do so.

Delivery To Pipeline

When the fluid is delivered to the pipeline the actual fluid handling cycle has been completed. From a unit process standpoint it is essential that this process be designed to accept processed fluid, to provide temporary fluid storage, to provide a means of measurement and to discharge the fluid according to the pipeline demands. In addition it must provide alarm signals from various points to insure that other processes are not impaired. This usually means the monitoring of surge tank levels, system back pressure, pump status, oil quality (at this stage of the art only for BS&W) and measuring device failure.

Data Gathering

Data gathering is a primary function of any automatic system. It is required in order to determine the results of other processes in the system. In a lease automation system these data may be classified into two basic categories:

1. Data required for efficient operational supervision
2. Data required for various accounting procedures

The latter can be the key to successful lease automation but is often overlooked or underrated during an evaluation.

In the stepwise approach to lease automation, automatic data gathering will be a key building block even though it will be recommended as one of the last stages to be installed.

Individual process alarms can be considered as data and plans should be made to include them in the data gathering system.

In an extensive lease automation system data are often required at several points or at a remote point. This usually leads to some type of communication link, be it radio, telegraph line or multiple wires. If the philosophy of complete unit operation is applied to this process, failure of the communication link should in no way affect the ability of the lease to produce or to market its products. Its failure could suspend well test and alarm data reporting but since each other process is self sufficient, local controls will allow the basic functions to be performed. Similarly, failure of other processes should not affect the communication link or data gathering system, but will only result in reporting of the failure.

The individual unit processes have been reviewed and a basic system philosophy has been set out, but until all these have been put together a lease automation system does not really exist. However, before a system is established one must have some aims or goals to accomplish. From a practical standpoint these goals can all be summed into one: EFFICIENCY. With these things in mind, the overall system can be approached.

STEPS IN SETTING UP THE SYSTEM

Automatic Custody Transfer

It has been the experience of the writers that, in most cases, the first process which can economically be automated is the pipeline delivery operation. There are many reasons for this but most are summarized in the following list.

1. From an efficiency standpoint, gaging and switching tanks is wasteful of human resources.
2. It is impractical to install other automated processes such as well test if it is necessary to daily gage and run tanks.
3. Of all the automatic lease processes, LACT has been most widely accepted.
4. An LACT process is completely useable by itself even if the operator decides to progress no further with a complete lease automation system.

Any of several types of custody transfer processes, if properly planned, can fit into an overall system. For system planning, some of the factors which should be considered when installing the LACT process should be:

1. Does the measuring method lend itself to future data storage and transmission?
2. Does the unit have clearly definined operational steps which can be remotely monitored and/or controlled?
3. Does the process have local controls to allow it to operate safely and accurately without dependence on the rest of the system?
4. Are signals available to prevent malfunction of this process from adversely affecting other parts of the system?

Automatic Well Flow Programming

Once the custody transfer process has been automated the next step might well be centralized flow control. Again, this is a sound second step because an economic saving will be attained whether or not further steps are taken towards an overall system.

At this point, however, the plans for the overall system should be fairly well formulated. This is chiefly due to the fact that the central flow programmer will undoubtedly be an electrical controller. Considerable savings can be made if the initial controller can be designed for its ultimate future use. Some factors to consider here might be:

1. Is it practical or possible or desirable to change the program from a remote point?
2. Is indication of the status of each well to be desired at a remote point?
3. Can groups of wells be programmed on the same basis or is individual control necessary?

Automatic Fluid Routing

Automating of the fluid routing process is the next logical

step in completing the lease automation system. In the step-wise approach this process should be designed to accomplish the following:

1. Well test
2. Fluid routing
3. Recording of measured quantities and qualities
4. Signalling of abnormal situations within its own process
5. Acceptance of and appropriate reaction to signals from other processes

The authors recommend the local recording of data due to the basic philosophy that each process be complete within itself. This will usually mean the use of visual counters, strip charts, simple printers, etc., at the site where the process is located. Depending upon the particular lease involved the recording devices can have various capacities.

For example, if an operator is required at the lease for maintenance reasons it may be feasible for him to pick up the data and reset the recorders on a weekly basis. In other cases it may be practical to do this daily or monthly. Considerable thought should be given to this process to insure that a data recording system is installed which will economically satisfy the particular lease requirements.

It will usually be necessary to add automatic controls such as high and low level detectors, pressure switches, flow-no-flow switches, etc., to the fluid processing equipment at this stage.

With the installation of these processes the lease has become an automatic system. Each process is operating and controlling itself. Interlocks or alarm signals have been provided to prevent one process from interfering with another and data is accumulated at the site for pickup by the operators.

Automatic Data Gathering

In many instances it may be desirable to add one more process to the lease system. This is automatic data gathering. Since this process will undoubtedly require a communication link it may be practical to add some remote control functions at this time. Since lease control consists mainly of ON-OFF process, it is relatively simple to provide these remote functions. Since the step-wise approach makes each process self controlled, serious thought should be given to the need for each remote function. Each should be examined to see how often it will de desirable or necessary to perform the function remotely and what it costs to perform it.

Likewise, a thorough study should be made with respect to which data will be automatically transmitted. Some of the questions which should be considered before this process is installed might be:

1. Where will the lease operators be located?
2. At what point should human operators make decisions regarding off-normal conditions?
3. In the event of an alarm, how much information does the operator need in order to know how to correct the trouble?
4. Should the data be gathered in a form suitable for automatic data processing machines?

It is the authors' opinion that the data transmission and remote control functions should be held to a minimum.

In many instances a categorical alarm such as "Station 3 Alarm" may be as useful as trying to transmit "High Pressure Separator High Level Station 3".

With each process self controlled, it will probably be necessary for the operator to actually go to the remote site to correct the difficulty. It is therefore practical to notify him only of where the trouble is located. Once he is there he can, from the local indications, determine the specific malfunctions.

Another example of where this philosophy might apply is in the matter of selecting well test time. Economically it is much more practical to select either a "fast" or "normal" test time than attempting to adjust the test time over a wide range.

It is the authors' belief that the data should be typed or printed out at a central office and that the printout device be capable of producing either punched tape or cards. The local data recording devices will provide the operators sufficient information to efficiently produce the lease. The printing machine will be better protected and receive better care in a central office. The punched tape or card byproduct will allow future automation of the office data handling process.

CONCLUSIONS

A STEPWISE approach to lease automation has been proposed. Such an approach offers several advantages, some of which are:

1. Each process will be retained as an independent unit.
2. Gradual change in duties and responsibilities of operating personnel.
3. Initial cost is held to a minimum.
4. The system limits need not be defined at the outset but may be changed at any point.