Application of SCADA in Refineries

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Abstract— *"Technology is the great growling engine that drives the contemporary world." Rightly said technology is always in motion and is ever evolving. Newer enhancements and developments help us achieve the unachievable and thus keeps on setting new standards and redefines the present ones. Technology is something infused into our daily lives and plays a crucial role in improving the standards of our work and progression. Latest advancements in the world of Computer Science and Informatics has hit the world with a storm. Thus incurring those advancements in the field of Petrochemicals and Oil & Gas is the need of the hour and these involvements can make the current industry productive. Acquisition and Interpretation of data are the important aspects handled by using computer frameworks. The Al grade modern automation technology works on the principal of remotely controlling and remotely accessing various equipment's using coded communication signals and channels. Data Acquisition system combined with storage compartments and hardware helps in the collection and secure data as well as creating a back-up. It can also be called a type of Industrial Control System (ICS). These systems use computer based architecture to connect various components to a single controlling and processing unit. But it differs from other types of ICS as it tends to comprise multiple sites, equipment and can work across a larger span of area. The paper deals with its implementation of SCADA in the refineries and as a whole in the downstream sector to improve its efficiency in fields of Health, Safety and Environment (HSE) as well as improved surveying and security. With proper implementation, it can revolutionize the current petrochemical industry.*

Keywords—SCADA, refineries, oil & gas, HSE, ICS, automation, Remote Controlling.

I. INTRODUCTION

Petrochemical refineries or oil refinery is a processing unit or plant where crude petroleum and gas is processed and refined into more useful and cleaner products like gasoline, petrol, diesel, kerosene, etc. They are comparatively very large, spawning huge industrial complexes with extensive and interconnected piping system running across the compound.The industry deals with excessive amounts of explosives and also with high amountsof toxins. Safety of the worker is always a crucial concern for the company. Thus, a petrochemical refinery is the heart of the downstream sector in petroleum domain. Improvements in technology are leading to more advanced and efficient industries and often increases and boosts productivity. Conventionally, industries rely on human resource for controlling, monitoring and inspecting various components of the refinery. But replacing it with a computer system reduces the error rate significantly and most importantly improves the response rate. Data collection is both smoother and faster.

II. THE NEED FOR A COMPUTERIZED SYSTEM IN REFINERIES

Preventive and reactive measure: As the industry deals with the refining of hydrocarbon, it is always with the threat of a severe calamity to strike and an automatic shutdown system is required for controlling the disaster. Moreover, dependency on the human for activation of automatic shutdown as well as to initiate safety procedures will create a delay which at some times, could be critical. Thus, a system is required which needs to be fast and efficient. Enhancing the overall efficiency of the system: A system required which functions to identify the damaged or broken part of the processing system. All parts of the system should be under surveillance (for, e.g., Gas detectors for checking the corrosion, leakage, etc.). Doing so would act as the initial step in crisis prevention and would improve the efficiency as the component be easily identified and replaced.

Recording and analysis of data: Many times we need to determine the properties of materials as well as create logs to store them. Mostly, these properties are interrelated and can be calculated simultaneously. Thus, comes the requirement of a mechanism for recording as well as storing the data altogether.

Security: Security is a prime aspect of any industry. It includes both limited access to specific areas, as well as a system to keep a check on who and where someone is entering. As industry deals with many explosive as well

as other harmful substances, a tight security is required and is the first step to preventing any mishap.Mustering head counts and individual identification: As the refineries are colossal in the area, a system is needed for identifying each worker, locating as well as keeping a scout on them.

Better security: As we are in the digital era, cyber-attacks are an ever growing threat. Thus, the industry needs an efficient system to tackle and prevent them.

III. DESIGN

Rightly called the backbone of modern day industry, an SCADA system at its most basic, is a software system that used in controlling, monitoring and analysing an industrial process. These systems utilized in every industrial process in the world like water, energy, oil and gas and much more.The SCADA system communicates with the various units attached to it (controllers) that are out on the field with the help of radio signals. The SCADA system will gather real-time information from these field controllers and can interpret and provide data in a format the user wants it to be a process. The SCADA allows the user to see what the process is doing, react to alarms, control the process, change settings and more. The SCADA system will also have some storage devices (cloud or solid drive) which allow it to track the process information over the long term during real-time analysis and thus store it. This data can be used by it to create charts, graphs and in this way the user can know what happened in the past as well along with the current data which can help him draft a plan for future actions. It can also be called a type of Industrial Control System (ICS). But it differs from other types of ICS as it tends to comprise multiple sites, equipment and can work across a larger span of area.

IV. COMPONENTS OF THE SCADA ARCHITECTURE

SCADA design operates on a system cohesively build across different software and hardware components. Some essential elements of the system are:

Remote terminal units (RTUs): The equipment is attached to process units so that the data can be gathered and collected from the group.

- Programmable Logic Controller (PLCs): These help in converting sensor signals to digital data. The telemetry hardware is not integrated into them thus making them more versatile and thus used in place of RTUs.
- Telemetry device connects RTUs and PLCs to a supervisory system (control system). Examples of wireless telemetry media employed in SCADA systems include satellite (VSAT), licensed and unlicensed radio, cellular and microwave.
- A data acquisition server which works on telemetry is used to provide a wireless connection between the various components of the system.
- Human Machine Interface (HMI): a critical aspect of SCADA architecture, it includes the ways by which user can operate and control the process and also can see the data gathered by surveillance of the process.

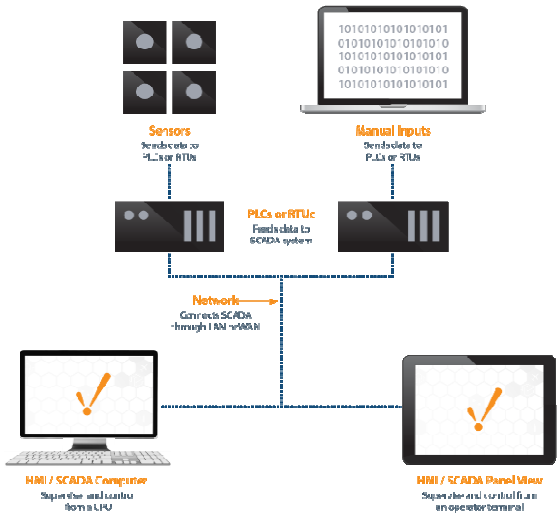


Fig. Primary SCADA architecture

V. WORKING

SCADA systems level at several software and hardware elements that allow industries to

- Monitor, collect and improvise data.
- Interact with and control machines and devices, pumps, motors, and more, connected through HMI (human-machine interface) software.
- Record events into a log file. The information from sensors or manual inputs collected sent to the PLCs (Programmable logic controllers) or RTUs (remote terminal units) which send that information to HMI(Human Machine Interface) with SCADA installed. Thus, effective SCADA can help in saving both time and money.

VI. PRIMARY APPLICATION OF SCADA IN REFINERIES

The main ways in which SCADA has improved and can enhance performance are:

- SCADA tremendously increases the safety and control systems of the pipelines. Not only it can detect minor to major leaks in pipes, but it can also take automatic action if programmed to do so in the case of a calamity or the user action to a persistent problem is delayed. It increases application of safety shutdown systems in the major locations, Lower

dependency on specialists or manual worker in case of any mishap. Alarm systems will also be more robust.

- It can be an efficient tool to help monitor the flow of crude oil and natural gas through pipelines. It can be used to collect data like flow rate, pressure, temperature, level, speed, Valve status, Pump status and much more.
- It can provide real-time data along with data in the form of charts, graphs collected over time.
- SCADA can be easily integrated with the CCTV systems and thus improves the security of the refinery. It can also be used to control the opening and closing of gates or doors so that only certain people with required authority can enter the particular part of the refinery.
- Workers provided with unique ID's punched against card readers. Card readers integrated with gates can be used to restrict people from entering certain locations thus improving the security of the premises. As workers will be required to punch the cards before entering the premises, these cards can also be used to muster head counts in the case of a calamity as the system will be able to provide data regarding where the card was last punched in the premises.
- SCADA can also provide power and energy management solutions.
- It can provide gas and fire detection and also provide emergency shutdown if necessary. Advanced process control functions improve the performance of highly matrixed and non-linear processes to help maximize asset performance. Easy and fast switching between valves of interconnected pipelines and thus giving rise to the rapid flow of materials through pipes.

VII. SCADA ARCHITECTURE

Though SCADA being very useful in itself, modern improvisations make it easier to use, portable and enhance its efficiency many folds. Some of the developments:

- •Web-based deployment: Instead of being installed by a worker if the service provider, the clients can download SCADA by the web on any of their devices as modern day SCADA is JAVA based and can run on any PC and only takes a few minutes to install. Unlimited Licensing: Pricing has significantly gone down as nowadays company tend to charge for the service as a whole (for the client) rather than individual components (tags). Thus, the user can add unlimited tags.
- •Security & Stability: These days SCADA comes with Industrial-grade security technology with a robust, unified architecture and built-in redundancy.
- Real-time data and monitoring: real-time status controls and analytics gives the power to analyse quickly and easily display the status of the facility. It also helps the client to stay in touch with the service wherever he is with constant notifications.
- Rapid Development: With SCADA architecture becoming easier to use and simpler in structure, they can be easily modified with the comparatively lesser amount of time. Moreover, up gradation in a single client will still allow access to the rest of the architecture.

VIII. MODERN DAY SCADA ARCHITECTURE

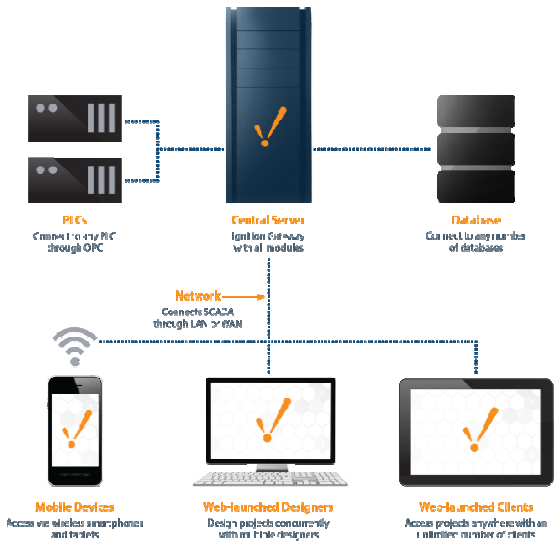


Fig. SCADA Architecture

IX. ACTUAL USAGE OF SCADA

The largest oil refinery of Indian Oil located at Gujarat and the monitoring of its energy consumption is inspected on a daily basis and is a continuous process. To be able to maintain the position of being most power efficient refinery, there is a need to automate a central SCADA system monitoring over the subsystems. The significant challenges that the company wanted to meet with a new automated SCADA system included the following:

- Improve operational efficiency
- Reduce operations and maintenance costs
- Reduce outages with auto-sectionalizing
- Improve coordination with plant substation
- Reduce outage minutes with restoration of significant load
- Improve load balancing

Gujrat refinery, to improve its efficiency, chose Honeywell's Experion PKS with built-in SCADA to provide a cloud-based control and to improvise its communications systems. With the deployment of

Honeywell's Solution SCADA, Gujrat Refinery was successfully transformed into a centralized system working efficiently and more and thus benefitting the business on the whole.

Employment of SCADA for efficient sour gas detection in Saudi Arabia.As there is a continuous demand for a higher production of oil and gas, situations may arise when newer fields may lie in an Emergency Planning Zone next to an inhabited township. Thus, to be able to balance constantly the safety of the residents with optimum production poses a challenge. One such problem observed in the region of Saudi Arabia. With optimum planning and cutting edge technology, experts were able to form a contingency plan where they developed a harmony between the safety of the individuals from gas leaks and quality production. They utilized environmental and gas monitors which were linked together through an integrated system named SCADA, providing a real-time analysis.With the utilization of both radio frequency and web-based system, real-time information was made accessible to the operator for tracking, monitoring and assessment. Since the information is instantly available, prompt actions in case of any emergency can be taken to avert any on-field disaster. A continuous record maintained in the cloud, and an SMS notification feature for the constant update to the operator also installed in the SCADA.The outburst of digitization in the oil fields has widened the scope for newer technologies both in drilling as well as safety technology, which have led to the treatment of sour wells in the most efficient way possible. Large manpower and resources employed in the past times, but with the application of SCADA, a reliable system formed which can reduce the labour and errors associated with it. Moreover, a change in perception of the public, from angst to content, has been observed due to the constant efforts of the experts to safeguard the community. With the application of these Portable monitoring systems, the people can heave a sigh of relief. The following case analyses the primitive and advance community safety systems and discusses the significance of using SCADA for detection of gas leaks to protect communities near the producing fields**.**

X. APPLICATION OF EQUIPMENT

H2S is a colourless, toxic and very flammable gas which is hazardous even at low concentrations. It is one of the primary cause of occupational catastrophe in Oil and Gas operations. As the complexity of the wells has increased manifolds, the primitive technologies like "fixed detection system" are incompetent in providing safety to the nearby settlements. Figure 1, depicts a fixed detection system which can detect only up to a certain range, thus offering a limited protection.

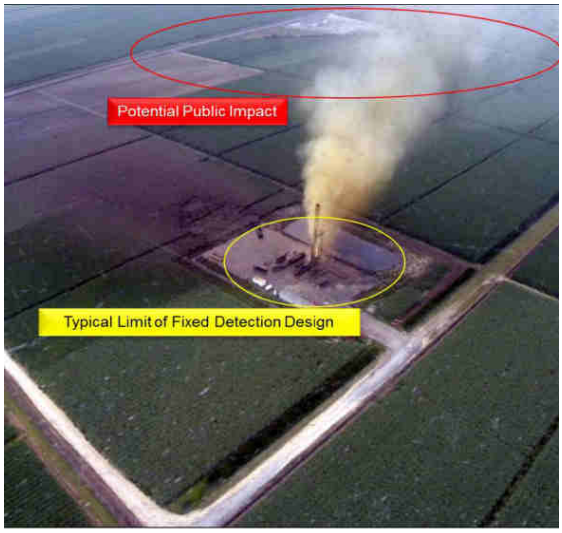
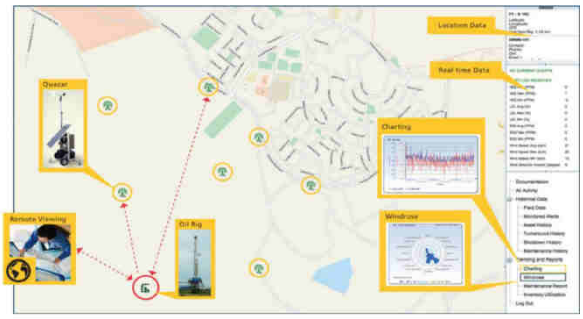


Figure 1—Conventional Fixed Gas Detection System's Limited Protection

As a precautionary method, the previous technologies were employed with communication systems which were incapable for larger distances.The current remote monitoring units equipped with robust communication systems monitored by the SCADA system which acts a medium to connect between various platforms. Thus, the present regime provides real-time data which is essential for quick decision making of an individual and on the whole, a network. The units deployed in a network in the vicinity of the drill site and they monitor the environment as well as the contamination gas levels in the atmosphere. The SCADA being the critical link transmits the data from these units to a central database which can be either automatic or operator handled. Thus, aggrandizing Emergency Preparedness, Planning, and Response.

The purpose of the SCADA enlisted in the following ways:

Keeps a track of the readings of the gas detectors and a leak is detected an immediate response message transmitted to the central system. If the response time exceeds the permissible limit, then it will initiate automatic shutdown procedure in case of a major leak. With the integrated GPS system, the movement of a gas cloud can be accurately detected. It also shows a real-time voltage reading of the solar panel which ensures the proper current supply to the unit and also informs about timely maintenance.Radio Frequency and web technologies used in the transmission of real-time data to the central unit further transferred to the cloud service of SCADA, accessed by any authorized personnel connected to that server. It also provides an SMS notification feature to the operators in case of any emergency.



SCADA System

Remote Monitoring Unit

The following table shows the detection time taken by SCADA and response time by the operator:

Leak Size (Shell DEP)	Flow MSm3/d	Detection Times	Response Times	LDS Gas Volume %	Company Specification Gas Volume %
Small Leak	N/A				1-5
Medium Leak	5.25	1440	6900	13	5-25
Large Leak	10.5	720	3400	26	25-50
Major Leak	17.5	360	1600	44	50-100

Detection time: It is the average time taken to detect a discrepancy in the system (leak in this case). But to avoid unnecessary action or lockdown even in the event of a minor incident, the system takes an average reading for a duration of time. During this period, the user is alarmed about it.

Response Time: In case the system detects a fault for some time and no action is taken by the user, the automatic steps were taken by the system is present according to the severity by the user.

Economic Aspect:

The economic viability of SCADA analysed through the cost of its components which is quite feasible.

	Ethernet	**Wlan**
Ethernet/PoE Port	$35	$35
Installation	$200	$250
Controller	-	$1,300 (50 users)
Access Points	-	$15,000 (50 APs)
CCTV Cameras	$255	$255
Gas Detectors	$210	$210
RTUs	$1,850	$1,850
PLUs	$1,250	$1,250
Manual input system	$1000	-
Central Server	NA	-

SCADA has been able to reduce dependency on humans and thereby to lead to a decrease in errors which further helps in preventing the loss that the company would have to bear because of it.

XI. CONCLUSION

Rightly said SCADA is the backbone of the modern industry.It provides the solution to many problems where human error can seep in.As modern industries require a robust system to improve the overall efficiency as well as improve the quality as well as some tasks performed, SCADA systems provide it intuitively.With overcoming limitations like power supply and internet stability, it can become a top-notch real-time monitoring system.

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