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SCADA FOR TANK MANAGEMENT SYSTEM IN REFINERIES

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Abstract: SCADA (Supervisory Control and Data Acquisition) have wide application in the management and monitoring of the operation of industrial plants and equipment in telecommunications, oil and gas industry, energy, wastewater systems and other fields. The aim of this paper is to present SCADA for tank management system at refineries. SCADA represents a system for monitoring, monitoring, archiving and control of industrial systems with parameter display, with the availability and reliability of such a system at a high level. These systems include a wide range of equipment, subsystems and technical solutions that enable the collection and processing of process data, and responding in an adequate optimal way. SCADA in industrial systems is the highest quality, but a costly solution. Its advantage is providing a consistent, intuitive development environment that allows software engineers to build applications quickly and easily, mobility, simple and quick installation, user friendly usage and accessibility.
Keywords: SCADA, Tank Management System, Custody transfer

1. INTRODUCTION

In order to increase the reliability and security of a tank management system and ensure economic feasibility, it is necessary to effectively address all technical, safety, organizational and environmental challenges and ensure compliance with the latest standards in this field [4], [5], [6]. Tank management systems should be designed according to the highest international standards of safety so staff, plant, and environment can be protected [6], [14]. It should ensure highest reliability and accuracy of all subprocesses within the system (custody transfer level and flow measurements, liquid and gas analysis, temperature measurements, etc.) and enable plant running in accordance to international laws and regulations. For all tank management systems, it is very important to determine the quality of petroleum products such as the water and sediment [1] and API gravity and sulfur content of crude oil and petroleum fractions [2]. Another important aspect is to enable highly accurate tank measurement with custody transfer approved level, temperature, and pressure instruments [10], [11], [14], [15]. Traditional automation and control uses hardware interfaces and custom designed algorithms to control a self-contained process. A HMI (Human Machine Iinterface) may be part of SCADA distributed control systems [13], [16]. SCADA (Supervisory Control And Data Acquisition) systems provide tools for analyzing, reporting, and fine-tuning those processes and monitoring a variety of plant data including: flows, motor current, temperatures, water levels, voltages, and pressure [12]. Alarms at central or remote sites triggered by any abnormal conditions are propagated to the HMI computer for operator's attention. In addition to alarms, important plant information will be logged in the HMI computer database for reports and trends [12]. SCADA systems and their applications in monitoring and controlling equipment and industrial plants are frequently used in following areas of researches: plant engineering, manufacturing, telecommunications, water and waste control, energy, oil and gas refining and transportation [7], [8].

Advantages of the SCADA system are its mobility, simple and quick installation, user friendly usage and accessibility [7]. Legislative unique metrology for tank management, oil transport control and management systems is used all around the world in area of oil, gas and petrol industry [1]. In our country this procedures and processes must be performed in accordance with „Law of planning and construction“ (“Official Gazette of Republic of Serbia, NO. 47/2003 and 34/2006, „Law on security and health at work in Republic of Serbia“ and „Fire protection and prevention Act“.

2. MATERIAL AND METHODS

When starting SCADA applications opens the home screen, where it is necessary to click anywhere on the screen to the middle opened a small window for logging. There are two types of users - with and without password. Password users have the ability to change alarm limits, simulate values, generate reports, and enter density for each tank, while password-free users only have the ability to monitor current values.In Fig.1. a screen for users without a password is displayed. The red box represents the currently selected user. If you want to change the user, click on his field. After selecting the user, the exit field (field X) is pressed, after which the main screen opens. If a user with a password is required, the box in the upper left corner ("Password users") is pressed. In this case, the following window opens.

Figure 1. Logging of SCADA system users

When logging is necessary to first select the user and then in the field below enter the password. Then ENTER is pressed and if the password matches the selected user, an “X” button will appear in the upper right corner. Pressing this button opens the SCADA system home screen as shown in Fig. 2.

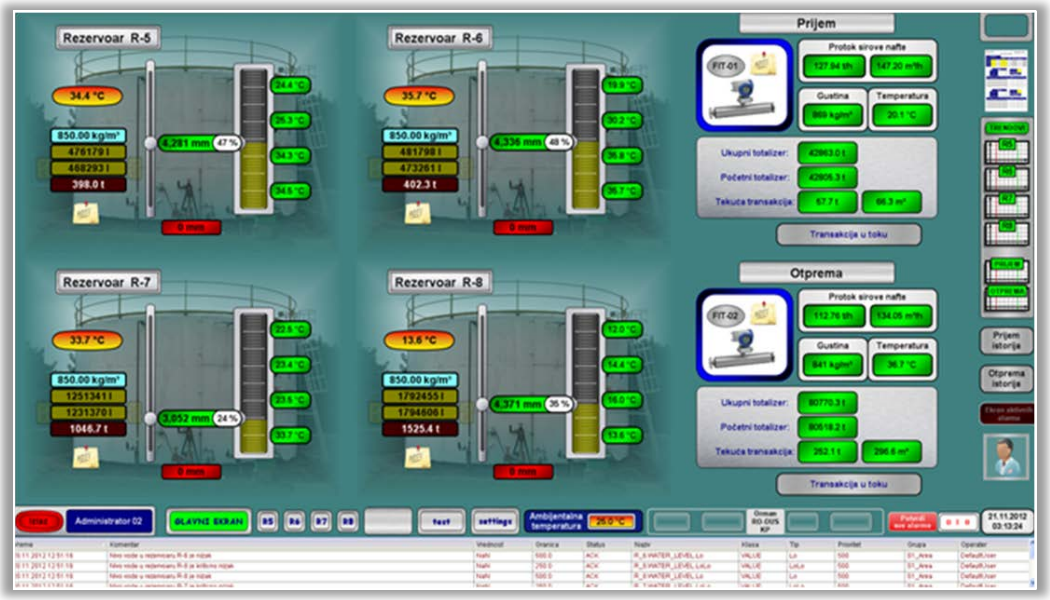


Figure 2. Main screen of SCADA application

At this location is measured to the reservoir 4, - R5, R6, R7 and R8, as well as the measurement of the flow of oil. The text below describes the system by which values are measured, alarms and simulated values are displayed, as well as settings that the user can use, as shown in Fig. 3. The temperature measurements in the reservoir are shown on the right, as shown in Fig. 4a. The lowest measured temperature is Temperature 01, while the highest temperature is displayed at the top 04. The field displaying temperatures can be colored in several ways:

— Green colored field - The value is displayed normally. No alarms are active or simulation is on.

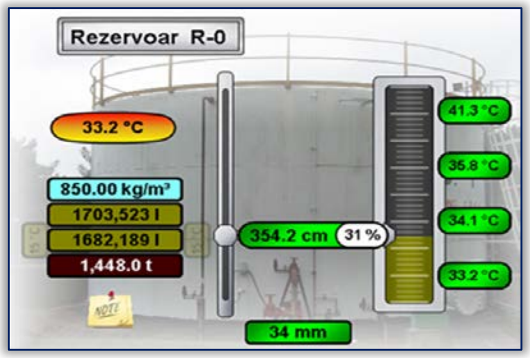
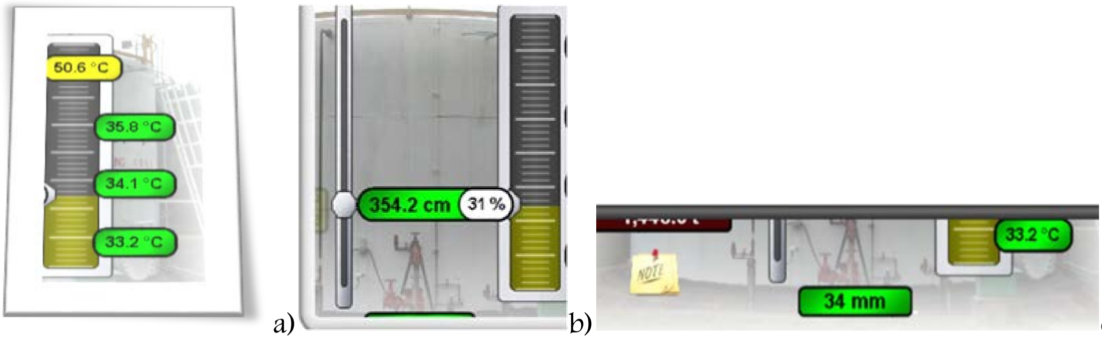


Figure 3. SCADA screen for displaying measured values, displaying alarms and simulated values

— Yellow colored field - A high or low alarm is activated. In case of a new (unconfirmed) alarm the field will move along a circular path. Only when the alarm is confirmed will the field be fixed in place. The difference between unconfirmed and already confirmed alarms is just that with "new" alarms the field is constantly moving.
— Red colored field - A critically high or critically low alarm is activated. The field behaves the same as when a "regular" alarm is activated, except that instead of yellow, the field is colored red.
— Purple colored field - A simulation of a given value is included. The field no longer shows the actual measured value, but the value entered manually.



a) b) c)

Figure 4. SCADA screen for Measuring the temperature, level and water level of a tank

Level measurements in the reservoir are shown at the very middle, as shown in Fig. 4b. The display on the left shows the level (in mm or cm), and immediately to the right next to it, what is the percentage of the maximum value. The field will move vertically with decreasing or decreasing levels. The bottommost position coincides with the bottom of the vertical opening / window to the right (zero value), while the far upper position coincides with the top of the opening to the right (100% level). The window to the right will also be filled vertically depending on the level in the tank. The color fields (green, yellow, red, and purple) behave the same way as the temperature display. The only difference is the way the new (unconfirmed) alarm is displayed.
As the temperature moves in a circle, the moving star will appear at the level immediately to the left of the level field. The asterisk will be visible while the alarm is unconfirmed.
The water level measurements in the tank are shown in the middle of the tank as shown in Fig. 4c. Field colors (green, yellow, red, and purple) behave the same as for temperature and level displays. If the alarm is new (unconfirmed), the water measurement display box will move left to right at the bottom of the screen.
The calculated average temperature is shown in the upper left part of the screen in Fig. 3, in the orange field. The system calculates the average temperature in relation to the level in the tank, ie. of the four temperature measurements (temperatures 01-04), only are taken into account those temperatures that are "submerged" at a given moment.
The system does not measure the density in the tank, but manually inputs the user as pinned in Fig. 5. The density (reduced to 15°C) is displayed (and entered) in the light blue field on the left side of the screen. The density is entered by clicking on the field, then entering the desired density via the keyboard, and finally pressing Enter.

Figure 5. SCADA screen for manual input density in the tank

The actual calculated volume is located just below the field for density. The actual volume is shown below the current volume (small markings for 15°C are next to it). At the bottom is in a brown field shows the calculated mass (for the density entered by the user). These four parameters are shown in Fig. 6.
The tank designation can be seen on the gray tile in the top in the left corner, above the tank image shown in Fig. 7. The blocked alarm sign in Fig. 7. appears when the alarm (one or more of them) is blocked by the user. Similarly, the active simulation sign in Fig. 7 occurs when a user has included one of the simulations, and no longer monitors the actual measurement.

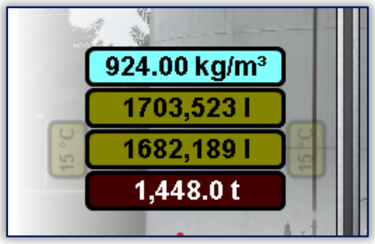


Figure 6. Density display, actual calculated sign, volume, reduced volume, calculated mass

Figure 7. Tank designation, Blocked alarm active simulation sign

The annotation box is opened by clicking on the note thumbnail (bottom left corner of the tank) as shown in Fig. 3. In the annotation window it is possible to enter the text of the message that the user wants to enter.

"See" in the system as shown in Fig. 8. After each text entry / edit, the user needs to click the button to confirm the entry. If the user thinks the message is important, it can trigger an alert. The alert is switched on and off by clicking on the warning sign (exclamation mark in the orange circle). A dimmed sign means the alert is not on. Also, if a warning is activated, the same will be visible on the main screen, next to the note thumbnail that calls the note window.

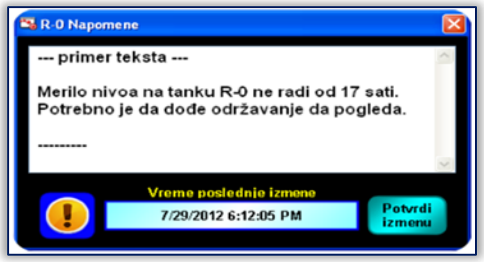


Figure 8. SCADA screen for Notes field

The value setting window opens by clicking on the value field in the main screen of Fig. 2. It is possible to adjust the level, water level, and any temperature (except average temperature). The alarm settings window opens by clicking on the field with this value in the main screen in Fig. 2. It is possible to set alarms for current flow (in tons), current density and current temperature. Adjustment windows look and behave the same as similar windows on tanks, as shown in Fig. 9. The only difference is that the flowmeter does not simulate these values in the system. The reservoir screens open full screen by clicking the buttons in the header below, as shown in Fig. 10.

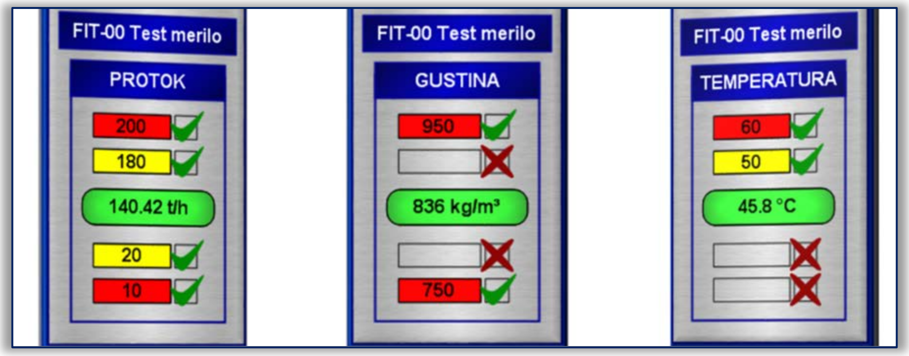


Figure 9. SCADA screen for Adjusting flow, density and temperature

Figure 10. SCADA screen for displaying all tank screens

The reservoir screen shown in Fig. 11 shows in one place all the settings and all values related to a given tank. There are all six setting windows (level, water level, temperatures 1-4), display of average temperature, volume (current and reduced), masses, annotation field, as well as commands for switching off / on all alarms and all simulations simultaneously.

On the right side of the window of Fig. 11 are the name of the value to be adjusted and the simulation field. Simulation is switched on and off by clicking on the square box. The box shows a green check mark when the simulation is active, and a red cross when inactive. When the simulation is active, it is possible to manually enter the value that the user wants to simulate. On the left side of the window in Fig. 11 there are alarm limits and a field showing the current value. Each alarm can be independently switched on / off, as well as changing my limit value. Low and high alarms are yellow beats, while critically low and critically high alarms are red. The center field with the current value behaves the same as the displays on the main screen (green, yellow, red, purple). A new (unconfirmed) alarm is displayed in a black box flickering around the center field.

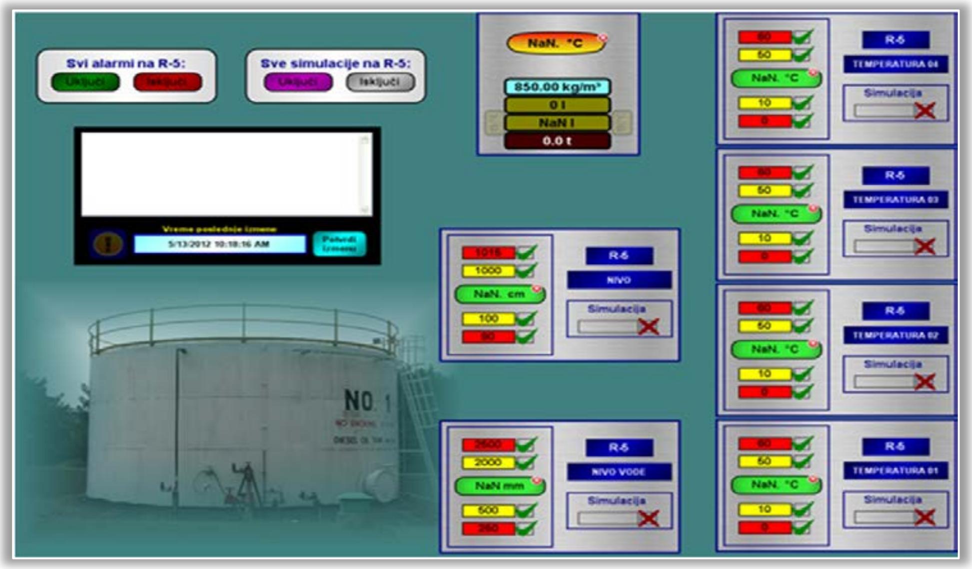


Figure 11. SCADA screen for Alarm setup, simulation

At the top of the view from the flowmeter in Fig. 12, we can see the name / function (eg receipt or dispatch). In addition to the image of the instrument and its name (ordinal number), there is a thumbnail of a note that clicks on the note window for that instrument. The notes work the same way as the tank notes.

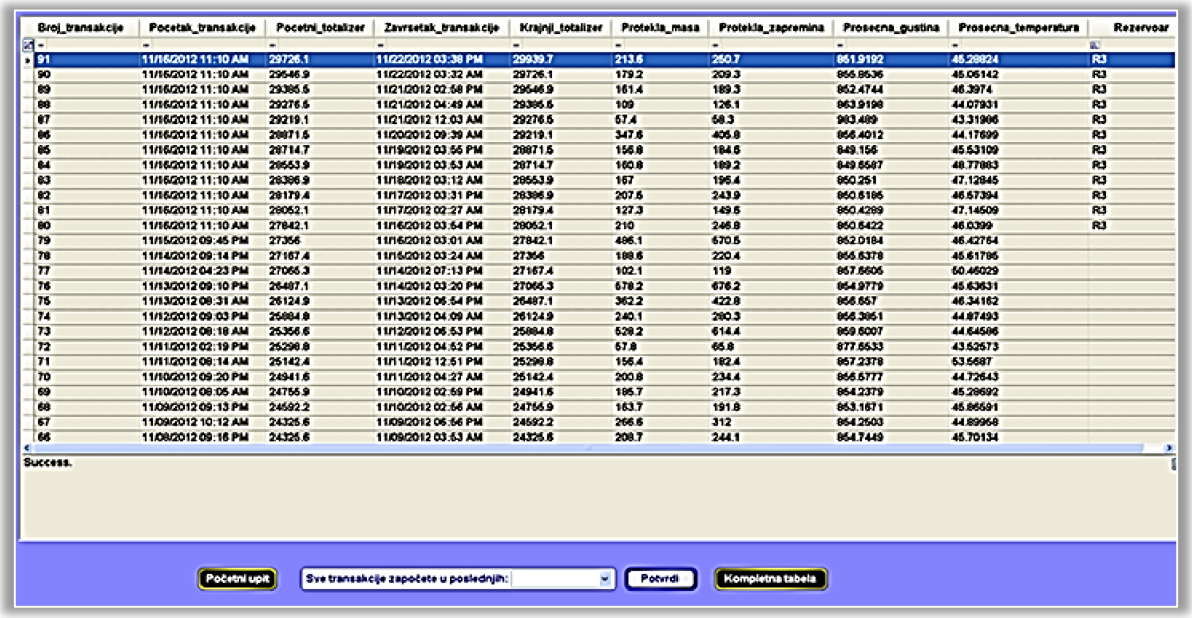
Current Flow Values Current density and temperature displays alarms if activated (yellow for high and low, red for critically high and critically low). If there is flow on the gauge, the blue frame around the image is called a circle. The total totalizer, the initial totalizer as well as the current transaction totalizer are displayed in the middle of the symbol (totalizers are displayed in tonnes and cubic meters).

Prior to the start of the shipment (transaction status is “Transaction not in progress”), it is necessary to notify the operators on the TUS TUS to press the START button. The START button is then pressed on the display or in the frame. The START button is visible if the transaction is not in progress and there is no flow. After pressing the button, a window opens for entering the tank from which the shipment is made.

Enter the tank name in the white box (or leave the previous value if appropriate) and press ENTER. Then it is necessary to press the START button and exit the window by pressing the "X" button. After pressing the START button, the transaction status will change to "Transaction in progress" and from that moment it is allowed to start the pump. Upon completion of the transaction it is necessary to press STOP and report to the TUS OUS to do the same. The STOP button is visible if the transaction is ongoing, the mass totalizer is greater than 2t and there is no flow through the pipeline. It is not necessary but desirable that both START and STOP be pressed immediately before and after the transaction. If pumping is interrupted, STOP is pressed only if it is the end of the batch. As soon as the STOP button is pressed, the batch is recorded to the SQL database and to history on the PLC [5]. At the same time, a report for the last transaction will be generated. The principle of receipt is the same as for the shipment with the batch start and end information being obtained from the shipment side.

Figure 12. SCADA screen for flow meters

The transaction history Fig. 13 on a given flowmeter opens by clicking the "Receive History" or "Upload History" button located on the right side of the screen in Fig. 2. The window that opens shows data for all transactions in the last week and this represents the initial query [12]. At the bottom of the screen is a button for displaying the complete table and a field for entering the period in which we are interested in transaction values. There are arrows on the right side of the screen to navigate through transaction history. Data can be sorted in descending / ascending order by a specific parameter (by clicking the column name in the table), and there are also filters (fields below the column name) to show only those transactions that interest us (e.g. if we are only interested in transactions where the total elapsed mass is greater than 500t).



Broj_transakcije	Pocetak_transakcije	Pocetni_totalizer	Zavrsetak_transakcije	Krajnji_totalizer	Protekla_masa	Protekla_zapremina	Prosecna_gustina	Prosecna_temperatura	Rezervoar
91	11/16/2012 11:10 AM	29726.1	11/22/2012 03:38 PM	29939.7	213.6	250.7	851.9192	45.28824	R3
90	11/16/2012 11:10 AM	29546.9	11/22/2012 03:32 AM	29726.1	179.2	209.3	856.8636	45.05142	R3
89	11/16/2012 11:10 AM	29385.5	11/21/2012 02:58 PM	29546.9	161.4	189.3	852.4744	46.3974	R3
88	11/16/2012 11:10 AM	29276.5	11/21/2012 04:49 AM	29385.5	109	126.1	863.9198	44.07931	R3
87	11/16/2012 11:10 AM	29219.1	11/21/2012 12:03 AM	29276.5	57.4	58.3	983.489	43.31906	R3
86	11/16/2012 11:10 AM	28871.5	11/20/2012 09:39 AM	29219.1	347.6	405.8	856.4012	44.17699	R3
85	11/16/2012 11:10 AM	28714.7	11/19/2012 03:55 PM	28871.5	156.8	184.6	849.156	45.53109	R3
84	11/16/2012 11:10 AM	28553.9	11/19/2012 03:53 AM	28714.7	160.8	189.2	849.6587	48.77883	R3
83	11/16/2012 11:10 AM	28386.9	11/18/2012 03:12 AM	28553.9	167	196.4	850.251	47.12845	R3
82	11/16/2012 11:10 AM	28179.4	11/17/2012 03:31 PM	28386.9	207.5	243.9	850.5195	46.57394	R3
81	11/16/2012 11:10 AM	28052.1	11/17/2012 02:27 AM	28179.4	127.3	149.5	850.4289	47.14509	R3
80	11/16/2012 11:10 AM	27842.1	11/16/2012 03:54 PM	28052.1	210	246.8	850.8422	46.0399	R3
79	11/15/2012 09:45 PM	27356	11/16/2012 03:01 AM	27842.1	486.1	570.5	852.0184	46.42754	
78	11/14/2012 09:14 PM	27167.4	11/15/2012 03:24 AM	27356	188.6	220.4	855.6378	45.61795	
77	11/14/2012 04:23 PM	27065.3	11/14/2012 07:13 PM	27167.4	102.1	119	857.5505	50.46029	
76	11/13/2012 09:10 PM	26487.1	11/14/2012 03:20 PM	27065.3	578.2	676.2	854.9779	45.63631	
75	11/13/2012 08:31 AM	26124.9	11/13/2012 06:54 PM	26487.1	362.2	422.8	856.657	46.34162	
74	11/12/2012 09:03 PM	25884.8	11/13/2012 04:09 AM	26124.9	240.1	280.3	856.3851	44.87493	
73	11/12/2012 08:18 AM	25356.6	11/12/2012 06:53 PM	25884.8	528.2	614.4	859.5007	44.64506	
72	11/11/2012 02:19 PM	25298.8	11/11/2012 04:52 PM	25356.6	57.8	65.8	877.5533	43.52573	
71	11/11/2012 08:14 AM	25142.4	11/11/2012 12:51 PM	25298.8	156.4	182.4	857.2378	53.5687	
70	11/10/2012 09:20 PM	24941.6	11/11/2012 04:27 AM	25142.4	200.8	234.4	856.5777	44.72643	
69	11/10/2012 08:05 AM	24755.9	11/10/2012 02:59 PM	24941.6	185.7	217.3	854.2379	45.29692	
68	11/09/2012 09:13 PM	24592.2	11/10/2012 02:56 AM	24755.9	163.7	191.8	853.1671	45.86591	
67	11/09/2012 10:12 AM	24325.6	11/09/2012 06:56 PM	24592.2	266.6	312	854.2503	44.89958	
66	11/08/2012 09:16 PM	24325.6	11/09/2012 03:53 AM	24325.6	208.7	244.1	854.7449	45.70134	

Figure 13. SCADA screen for transaction history

3. RESULTS AND DISCUSSION

Sometimes there may be a loss (or poor status) of communication between computers and devices in the field [3], [9]. The most common causes of such problems are malfunctioning devices in the field, cabinet equipment, problems with connections (cables), and possible problems with the operation of the computer itself (eg after a violent reset or loss of power). Poor communication status is displayed on SCADA by "screwing" a field that shows a given value. It does not matter whether the value is given in the alarm (red or yellow field), whether it is simulated (purple field), or whether it is a regular value (green field). In some cases, the field may display the correct value, but in most cases it is the wrong value (due to poor communication status).

Loss of communication, as well as a problem or error in communication, are displayed on SCADA by special graphic symbols that are invisible during normal communication. The communication error symbol is a small red circle with a white X sign in the middle. The symbol appears next to the field that shows the given value. Instead, a question mark, a wrench, an hourglass and some others may be heard in less frequent cases. The only good communication is when none of these signs are seen next to the value field.

4. CONCLUSIONS

Directions for further development of the application of SCADA are the creation of a unique dissemination center from which data in tank management system will be available. Contemporary data processing involves real-time data collection and storage, and information on each control process parameter can be obtained at any time from any location on the cloud storage. SCADA associated with automated processes enables the graphical display of data on the screen, along with numerical values, in a format suitable for the operator. In addition to the graphical representation of the application's user interface, SCADA system also allows display of certain alarms if some of the parameters go outside of the specified range.

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