DRAWINGS

Figure 1

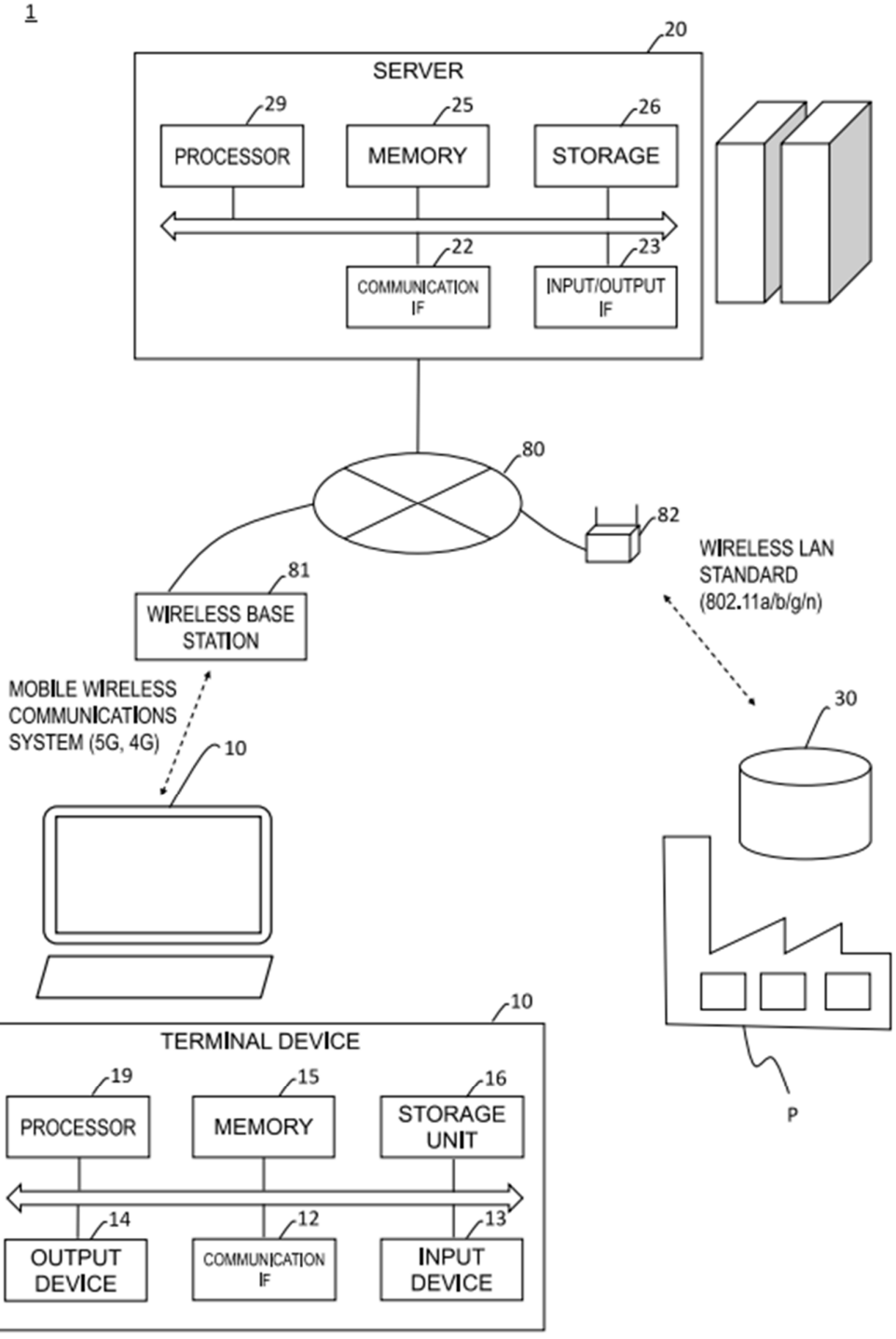


Figure 2

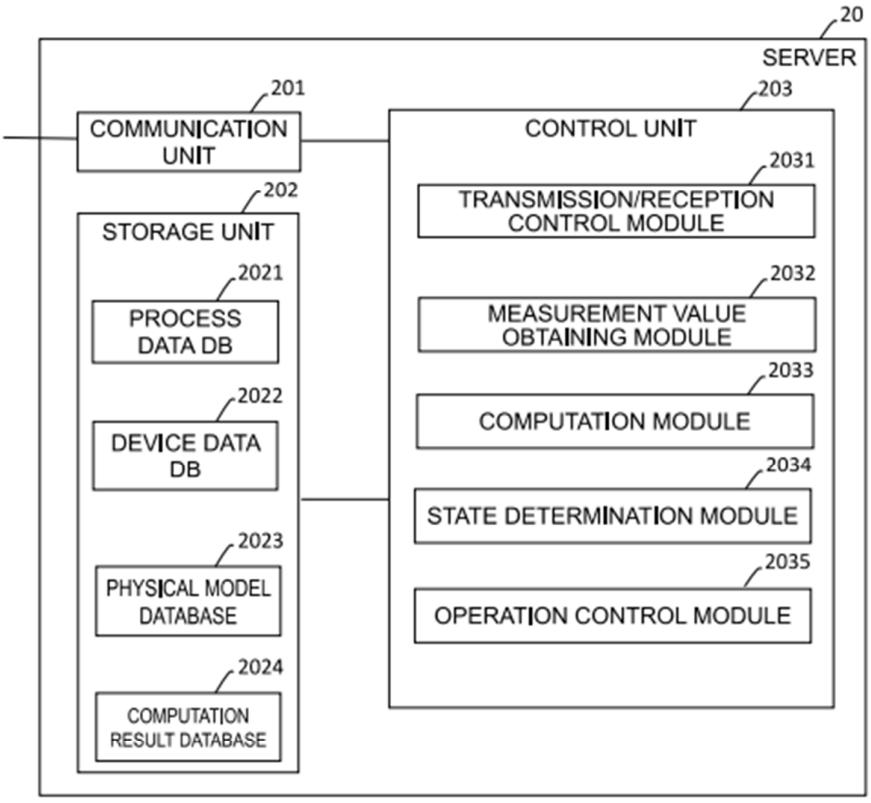

20
SERVER
201
COMMUNICATION UNIT
202
STORAGE UNIT
2021
PROCESS DATA DB
2022
DEVICE DATA DB
2023
PHYSICAL MODEL DATABASE
2024
COMPUTATION RESULT DATABASE
203
CONTROL UNIT
2031
TRANSMISSION/RECEPTION CONTROL MODULE
2032
MEASUREMENT VALUE OBTAINING MODULE
2033
COMPUTATION MODULE
2034
STATE DETERMINATION MODULE
2035
OPERATION CONTROL MODULE

Figure 3

2021

PROCESS DATA DB			
SENSOR ID	DEVICE NAME	SENSOR NAME	MEASUREMENT VALUE
#10001	PUMP A	PRESSURE GAGE	···
#10002	PUMP A	FLOWMETER	···
#10003	PUMP A	THERMOMETER	···
···	PUMP B	PRESSURE GAGE	···
···	PUMP B	FLOWMETER	···
···	PUMP B	THERMOMETER	··
···	HEAT EXCHANGER	···	··
···	···	···	··
···	···	···	··
···	···	···	··

2022

DEVICE DATA DB			
SENSOR ID	DEVICE NAME	SENSOR NAME	MEASUREMENT VALUE
#20001	VALVE A	VALVE OPENING INDICATOR	···
#20002	VALVE B	VALVE OPENING INDICATOR	···
#20003	VALVE C	VALVE OPENING INDICATOR	···
···	VALVE D	VALVE OPENING INDICATOR	···
···	···	···	···
···	···	···	··
···	···	···	··
···	···	···	··
···	···	···	··
···	···	···	··

Figure 4

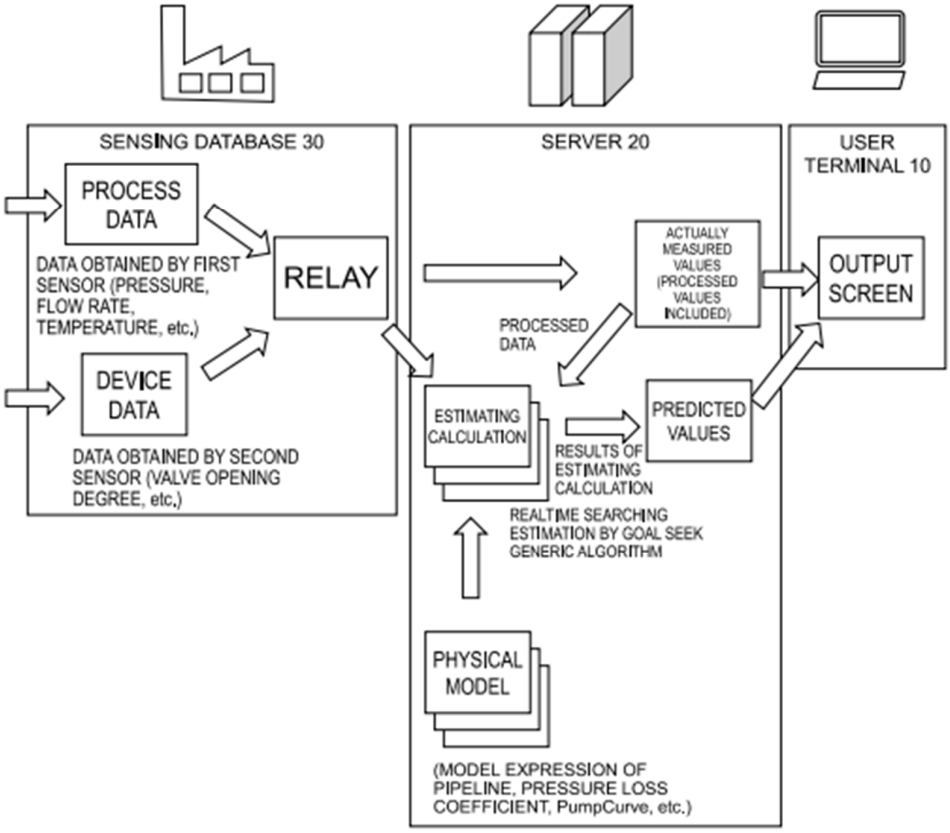

SENSING DATABASE 30
PROCESS DATA
DATA OBTAINED BY FIRST SENSOR (PRESSURE, FLOW RATE, TEMPERATURE, etc.)
RELAY
DEVICE DATA
DATA OBTAINED BY SECOND SENSOR (VALVE OPENING DEGREE, etc.)
SERVER 20
ACTUALLY MEASURED VALUES (PROCESSED VALUES INCLUDED)
PROCESSED DATA
ESTIMATING CALCULATION
RESULTS OF ESTIMATING CALCULATION
PREDICTED VALUES
REALTIME SEARCHING ESTIMATION BY GOAL SEEK GENERIC ALGORITHM
PHYSICAL MODEL
(MODEL EXPRESSION OF PIPELINE, PRESSURE LOSS COEFFICIENT, PumpCurve, etc.)
USER TERMINAL 10
OUTPUT SCREEN

Figure 5

Figure 5A

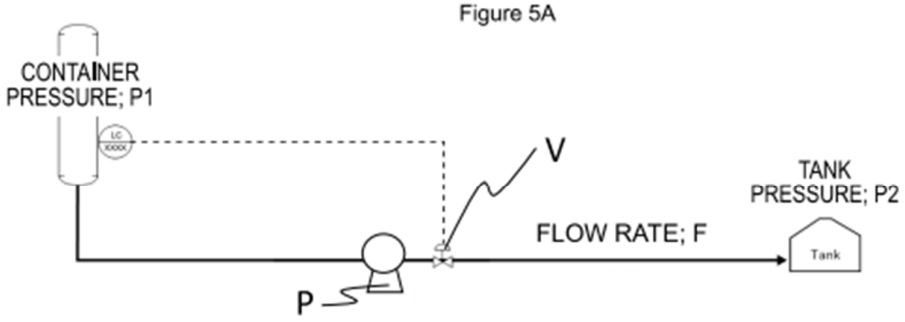


Figure 5B

CONTAINER PRESSURE (ACTUALLY MEASURED VALUE)	VALVE OPENING DEGREE (ACTUALLY MEASURED VALUE)	FLOW RATE (ACTUALLY MEASURED VALUE)		TANK PRESSURE (PREDICTED VALUE)		TANK PRESSURE (ACTUALLY MEASURED VALUE)
P1				PREDICTED P2		P2
kPaG	%	m3/h		kPa		kPaG
500	55	120	=>	195	⇔	200

Figure 5C

CONTAINER PRESSURE (ACTUALLY MEASURED VALUE)	TOLERABLE MAX DEGREE OF OPENING	VARIABLE		TANK PRESSURE (PREDICTED VALUE)		TANK PRESSURE (ACTUALLY MEASURED VALUE)
P1	VALVE OPENING DEGREE	FLOW RATE		PREDICTED P2		P2
kPaG	%	m3/h		kPa		kPaG
500	85%	140	=>	300	⇔	200
500	85%	160	=>	250	⇔	200
500	85%	180	=>	200	⇔	200
500	85%	200	=>	150	⇔	200
500	85%	220	=>	100	⇔	200
500	85%	240	=>	50	⇔	200

Figure 6

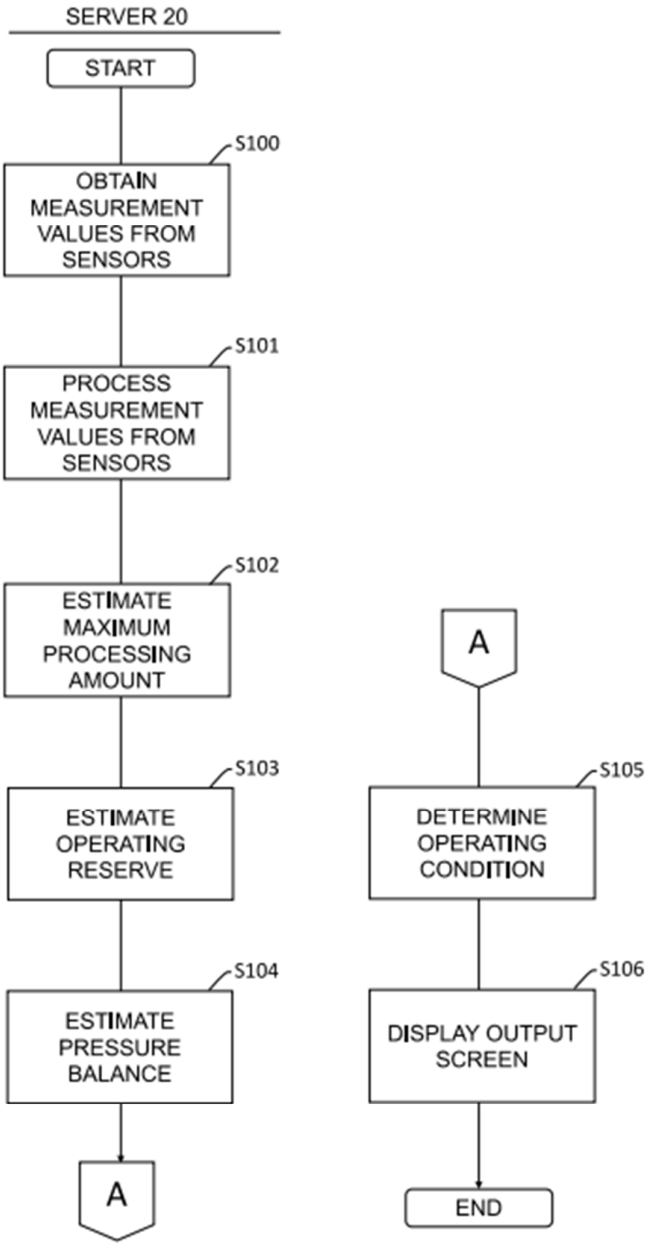

SERVER 20
START
S100
OBTAIN MEASUREMENT VALUES FROM SENSORS
S101
PROCESS MEASUREMENT VALUES FROM SENSORS
S102
ESTIMATE MAXIMUM PROCESSING AMOUNT
S103
ESTIMATE OPERATING RESERVE
S104
ESTIMATE PRESSURE BALANCE
A
A
S105
DETERMINE OPERATING CONDITION
S106
DISPLAY OUTPUT SCREEN
END

Figure 7

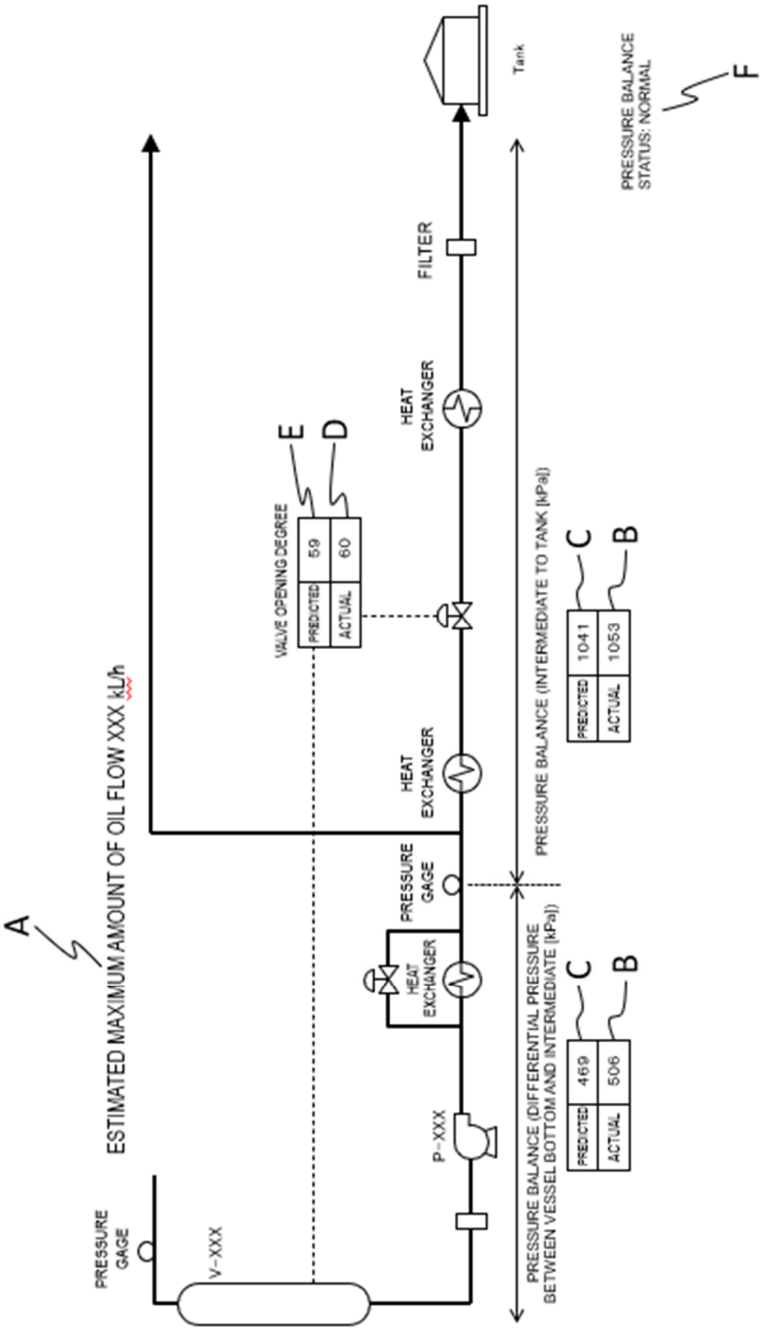

A
ESTIMATED MAXIMUM AMOUNT OF OIL FLOW XXX kL/h
PRESSURE GAGE
V-XXX
P-XXX
HEAT EXCHANGER
PRESSURE GAGE
HEAT EXCHANGER
HEAT EXCHANGER
FILTER
Tank
VALVE OPENING DEGREE
PREDICTED 59
ACTUAL 60
E
D
PRESSURE BALANCE (INTERMEDIATE TO TANK [kPa])
PREDICTED 1041
ACTUAL 1053
C
B
PRESSURE BALANCE (DIFFERENTIAL PRESSURE BETWEEN VESSEL BOTTOM AND INTERMEDIATE [kPa])
PREDICTED 469
ACTUAL 506
C
B
PRESSURE BALANCE STATUS: NORMAL
F

Figure 8

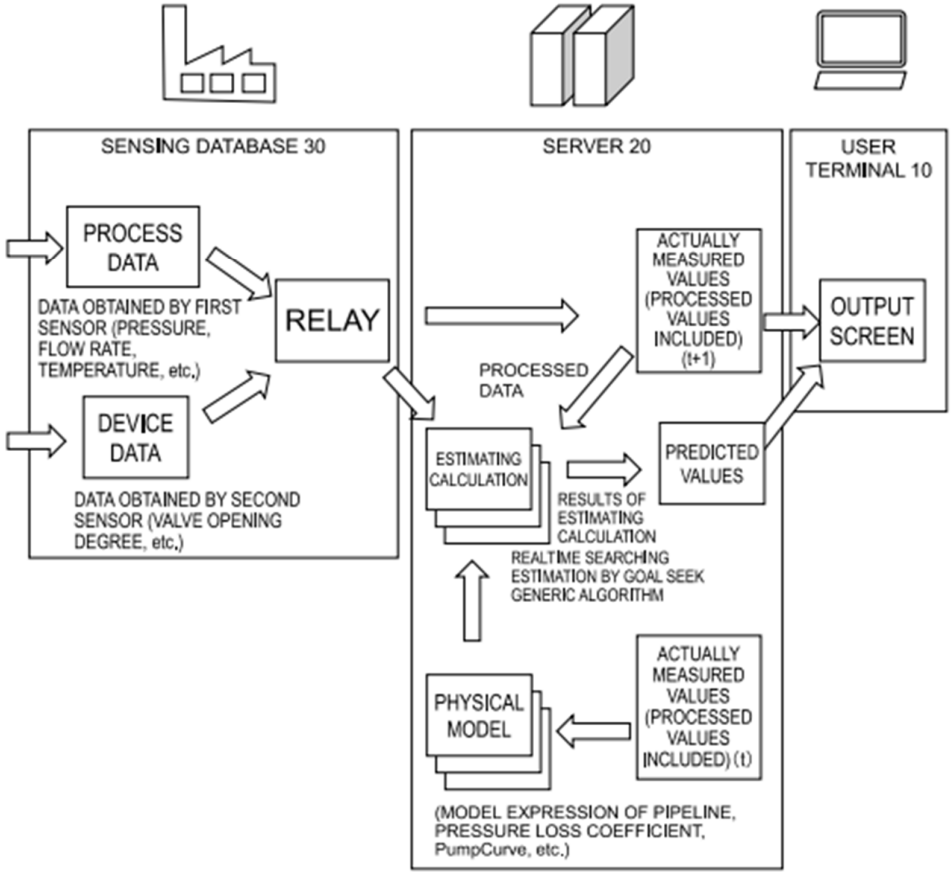

SENSING DATABASE 30
SERVER 20
USER TERMINAL 10
PROCESS DATA
DATA OBTAINED BY FIRST SENSOR (PRESSURE, FLOW RATE, TEMPERATURE, etc.)
RELAY
DEVICE DATA
DATA OBTAINED BY SECOND SENSOR (VALVE OPENING DEGREE, etc.)
ACTUALLY MEASURED VALUES (PROCESSED VALUES INCLUDED) (t+1)
OUTPUT SCREEN
PROCESSED DATA
ESTIMATING CALCULATION
PREDICTED VALUES
RESULTS OF ESTIMATING CALCULATION
REALTIME SEARCHING ESTIMATION BY GOAL SEEK GENERIC ALGORITHM
ACTUALLY MEASURED VALUES (PROCESSED VALUES INCLUDED) (t)
PHYSICAL MODEL
(MODEL EXPRESSION OF PIPELINE, PRESSURE LOSS COEFFICIENT, PumpCurve, etc.)

Figure 9

Figure 9A

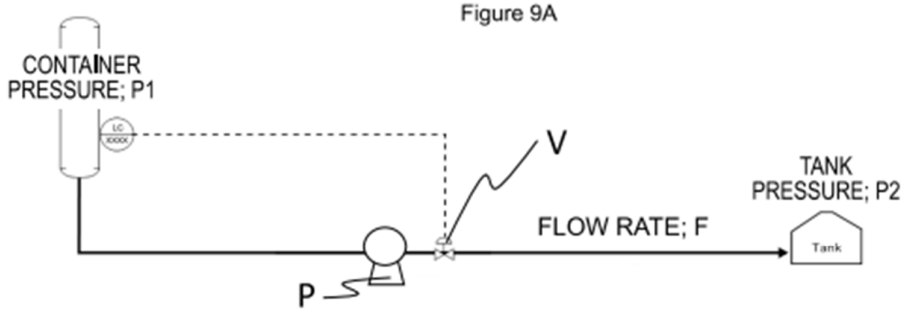


Figure 9B

CONTAINER PRESSURE (ACTUALLY MEASURED VALUE)	ACTUALLY MEASURED VALUE OF VALVE OPENING DEGREE	ACTUALLY MEASURED VALUE OF FLOW RATE	Kpipe1 (VARIABLE)	ΔPpipe1	Kpipe2 (VARIABLE)	ΔPpipe2	ΔPcv		TANK PRESSURE (PREDICTED VALUE)		TANK PRESSURE (ACTUALLY MEASURED VALUE)
P1									PREDICTED P2		P2
kPaG	%	m3/h	-	kPa	-	kPa	kPa		kPa		kPaG
500	55	120	1.75	-52.5	0.84	-58.8	-155	=>	233.7	⇔	200
500	55	120	1.9	-57	1.03	-72.1	-155	=>	215.9	⇔	200
500	55	120	1.94	-58.2	0.95	-66.5	-155	=>	220.3	⇔	200
500	55	120	2.12	-63.6	1.54	-107.8	-155	=>	173.6	⇔	200
500	55	120	**1.83**	-54.9	**1.23**	-86.1	-155	=>	204	⇔	200

=> Determine to use this k1

=> Determine to use this k2

G G

Figure 9C

CONTAINER PRESSURE (ACTUALLY MEASURED VALUE)	TOLERABLE MAX DEGREE OF OPENING	VARIABLE	Kpipe1	ΔPpipe1	Kpipe2	ΔPpipe2	ΔPcv		TANK PRESSURE (PREDICTED VALUE)		TANK PRESSURE (ACTUALLY MEASURED VALUE)
P1	VALVE OPENING DEGREE	FLOW RATE							PREDICTED P2		P2
kPaG	%	m3/h	-	kPa	-	kPa	kPa		kPa		kPaG
500	85%	140	1.83	-90	1.23	-100	-10	=>	300	⇔	200
500	85%	160	1.83	-110	1.23	-120	-20	=>	250	⇔	200
500	85%	180	1.83	-130	1.23	-140	-30	=>	200	⇔	200
500	85%	200	1.83	-150	1.23	-160	-40	=>	150	⇔	200
500	85%	220	1.83	-170	1.23	-180	-50	=>	100	⇔	200
500	85%	240	1.83	-190	1.23	-200	-60	=>	50	⇔	200

Figure 10

