

WATER ADDITION TO WAMUS DIRTY GAS SYSTEM.

ENGINEERING NOTE

3823.134-EN-581

February 16, 2006

Author: Mike Sarychev

Water addition to WAMUS Dirty gas system.

Total flow through the whole WAMUS Dirty system – 135 l/min;

Currently, H₂O content is 600 ppm (0.45 mg/l).

In order to rise H₂O content to 1500 ppm (1.2 mg/l), we need to add 0.75 mg/l.

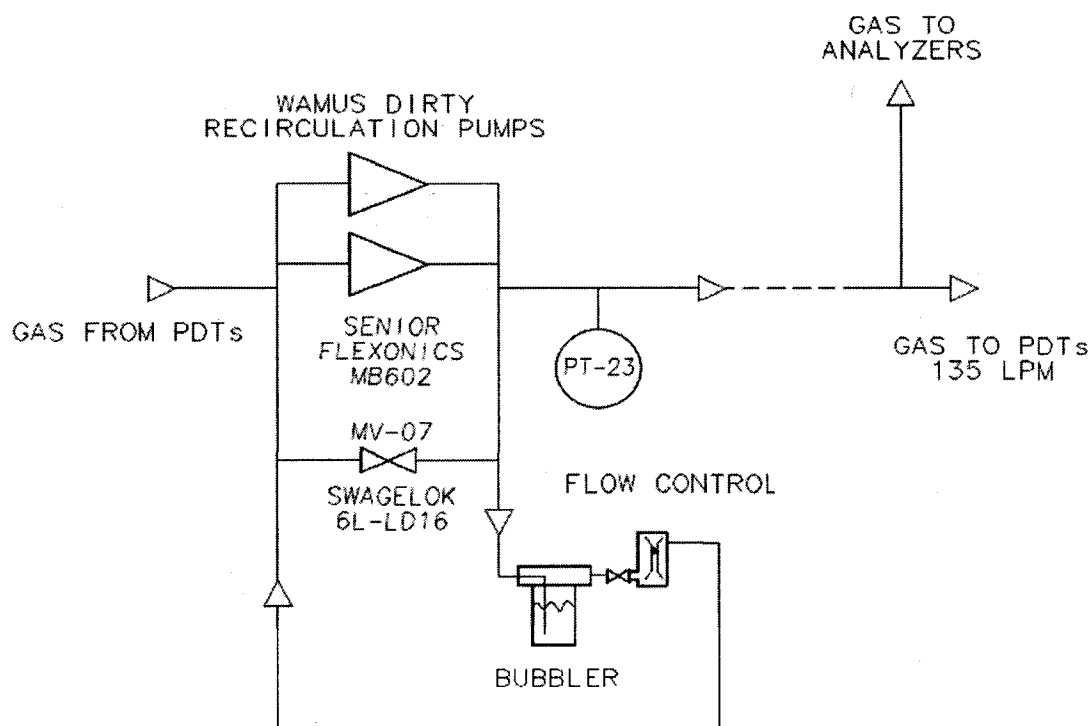
In order to rise H₂O content to 2500 ppm (1.8 mg/l), we need to add 1.35 mg/l.

Gas flowing through a bubbler filled with water at room temperature – 23 C (saturated) has water content of 23 mg/l, therefore, flow through a bubbler has to be 4.4 l/min (to get 1500 ppm); or 7.9 l/min (to get 2500 ppm).

WAMUS Dirty system volume is 240 m³. It will need 180 g to increase H₂O content to 1500 ppm or 325 g to go to 2500 ppm. It will take 1.25 days (or 2.25 days to go to 2500 ppm with 4.4 l/min flow).

Steady state flow through a bubbler will be 0.5 l/min to maintain 1500 ppm and 0.8 l/min to maintain 2500 ppm. Water usage will be around 17.5 ml per 24 hours for 1500 ppm; or around 26 ml per 24 hours for 2500 ppm.

Proposed flow diagram:



A bubbler and a flow controller (0-5 lpm or 0-10 scfh) can be connected in parallel with MV-07 pumps bypass valve in room 510 (we have available ports in existing piping to do it). Existing analyzers will be used to check H₂O content in gas.

Water addition to a single PDT test.

Total flow through the whole WAMUS Dirty system – 135 l/min;

72 PDT in the system;

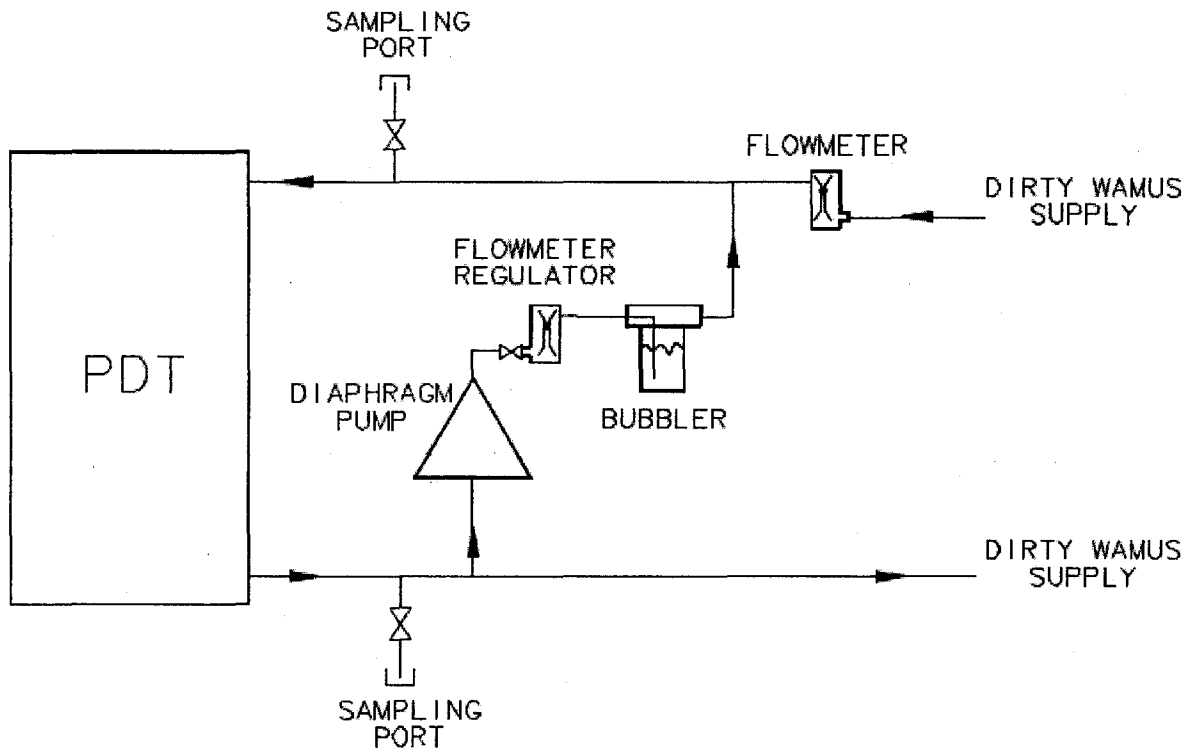
Estimated flow through a single WAMUS Dirty system PDT – 1.875 l/min.

Currently, H₂O content is 600 ppm (0.45 mg/l); need to rise to 2500 ppm (1.85 mg/l) – add 1.4 mg/l.

Gas flowing through a bubbler filled with water at room temperature – 22 C (saturated) has water content of 19 mg/l, therefore flow through a bubbler has to be 0.14 l/min or 0.29 ft³/hr.

Water usage will be around 4 ml per 24 hours.

Proposed flow diagram:



SHAW hygrometer might be used to monitor water content. 2500 ppm correspond to –10 C Dew point.

PDT to be tested is one of four suggested by Penny Kasper – 123, 207, 230 or 133 – will be chosen after Collision Hall access and site inspection (the easiest one to reach and access to in-out ports, power outlet nearby, probably a TV camera to watch hygrometer readings).



SUBJECT

Water addition to a single PDT

NAME

M. Stryker

DATE

01/05/06

REVISION DATE

Currently 600 ppm \rightarrow 0.45 mg/L
needs 2500 ppm \rightarrow 1.85 mg/L
 \Rightarrow add 1.4 mg/L

@ 22°C D.P. \rightarrow H₂O content = 19 mg/L

Average flow thru a single PDT

$$135/72 = 1.875 \text{ L/min}$$

flow needed: $1.4 \text{ mg/L} \times 1.875 \frac{\text{L}}{\text{min}} = 2.625 \text{ mg/min}$

$$Q = \frac{2.625 \text{ mg/min}}{19 \text{ mg/L}}$$

$$\begin{aligned} &= 0.14 \text{ L/min} \\ &= 0.29 \text{ ft}^3/\text{HR} \end{aligned}$$

Water usage $2.625 \text{ mg/min} = 157.5 \text{ mg/hr} = 3.78 \text{ g/day}$
(1 teaspoon = 5g)

Flowmeter readings:

$$Q = \frac{\text{SCFH AIR}}{f}$$

$$f = \sqrt{\text{Spec. gravity}}$$

SG: CH₄ = 0.55, CF₄ = 3.028 AR = 1.38

$$SG_{\text{min}} = 0.02 \cdot 0.55 + 0.02 \cdot 3.028 + 0.84 \cdot 1.38 = 1.45$$

$$f = 1.2$$

$$\text{SCFH AIR readings} = 0.29 \cdot 1.2 = \underline{\underline{0.35 \text{ scfh}}}$$



SUBJECT

 H_2O addition to WAMUS dirty
(initial)

NAME

M. Haychev

DATE

02/16/06

REVISION DATE

Dirty WAMUS H_2O content $\sim 600 \text{ ppm} \rightarrow 0.45 \text{ mg/l}$

1500 ppm $\rightarrow 1.2 \text{ mg/l}$

2500 ppm $\rightarrow 1.8 \text{ mg/l}$

Dirty WAMUS flow $\approx 135 \text{ l/min}$

add'l H_2O

- for 1500 ppm:

$$(1.2 - 0.45) \text{ mg/l} \times 135 \text{ l/min} = 101.25 \text{ mg/min}$$

for 2500 ppm

$$(1.8 - 0.45) \times 135 = 182.25 \text{ mg/min}$$

@ 23°C , sat. gas has $23 \text{ mg/l } H_2O$

Req'd flow

- for 1500 ppm: $\frac{101 \text{ mg/min}}{23 \text{ mg/l}} = 4.4 \text{ l/min}$

- for 2500 ppm $\frac{182}{23} = 7.9 \text{ l/min}$

Water usage:

- 1500 ppm $\rightarrow 101.25 \text{ mg/min} = 145.8 \text{ g/day}$

- 2500 ppm $\rightarrow 182.25 \text{ mg/min} = 262.4 \text{ g/day}$

Dirty system volume - 240 m^3

180g needs to be added to increase to 1500 ppm

324g

to 2500 ppm

Will take 1.25 days.



SUBJECT

H₂O addition to W. Ditch - Steady state

NAME

M. Sapychev

DATE

02/16/06

REVISION DATE

$\approx 9-10$ lpm make-up flow with oppm
at 1500 ppm $\rightarrow 1.2$ ug/l
at 2500 ppm $\rightarrow 1.8$ ug/l

addition: for 1500 ppm - 12 ug/min
for 2500 ppm - 18 ug/min

Sat. gas @ 23°C $\rightarrow 23$ ug/l

flow req'd: $\frac{12}{23} = 0.522$ l/min
(1.1 ft³/hr)
for 1500 ppm

$\frac{18}{23} = 0.783$ l/min (2.76 ft³/hr)

Water usage

1500 ppm - 17.3 g/day

2500 ppm - 26 g/day