Testing 201: Gravity Grease Interceptors (GGIs)

Tackling a 2000 lb gorilla

Dr. Greg Williams, P.Eng.
Managing Director, Good Harbour Laboratories
NSF FOG Workshop, February 27, 2018

Definitions & Basics

Interceptor Definitions

- The Uniform Plumbing Code refers to ASME A112.14.3, which is very general:

  - Grease interceptor: plumbing appurtenance(s) that is (are) installed in the sanitary drainage system in order to intercept oily and greasy wastes from wastewater discharges

Definitions & Basics

Interceptor Definitions Cont'd

- However A112.14.3 does specify that the flow rating must be < 100gpm (or it can't be tested) and the installation must be one of 4 types:

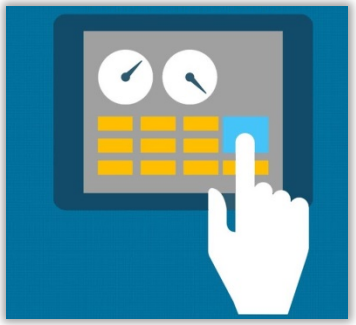
1. External flow control, with air intake, direct
2. External flow control without air intake, direct
3. No external flow control, direct
4. No external flow control, indirect

Definitions & Basics

HMI'S

- Some time between 1996 and 2007, the Foreword of G-101 started to state the difference between HMIS and GGIs
  - hydraulic flow action + air entrainment + gravity vs. gravity
  - Also, HMIs follow the flow and installation constraints of A112.14.3

- By 2009 the definition of HMI made it into IAPMO IGC 273



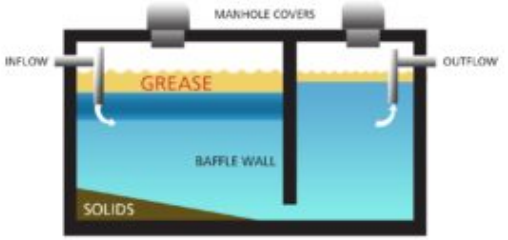
Definitions & Basics

Interceptor Definitions - GGI

- Gravity Grease Interceptors (GGIs) – from the 2009 Uniform Plumbing Code:

A plumbing appurtenance or appliance that is installed in a sanitary drainage system to intercept nonpetroleum fats, oils, and greases (FOG) from a wastewater discharge and **is identified by volume, thirty (30) minute retention time, baffle(s), not less than two (2) compartments, a total volume of not less than three-hundred (300) gallons, and gravity separation**.

[These interceptors comply with the requirements of Chapter 10 or are designed by a registered professional engineer.] Gravity grease interceptors are generally installed outside.



GREASE INTERCEPTOR

HMI vs GGI

- Since the distinction is relatively recent and appears only in the Foreword of PDI G-101 and not in the body it seems a little informal but it is widely accepted now
  - Good or bad the distinction is useful
- What about retention time?

Retention Time

- **GGIs** have a 30 min retention time, *per* the UPC
- Since they also have a minimum volume (300 gal) they have a minimum flow rate of 10 gpm
  - There is no maximum flow rate

- **HMI** have a 1 min retention time *per* ???
  - PDI G-101 Section 3.1, specifies 2 compartments, Section 5.3 specifies that compartment volume (gal) = flow rate (GPM), Section 7.3 specifies discharging both sinks, therefore PDI implies a 2 minute test. ASME112.14.3 specifies ≤126 s
- No where is retention time actually specified
  - The volume of the unit is not discussed

Why does this matter?

- The fact that a 1 minute retention time for HMIs is generally accepted but not written into actual test protocols, along with the other definition we have discussed, creates a situation in which testing GGIs is not currently possible
- This will be discussed in the next section

Existing Test Protocols

Existing Test Protocols

Existing Performance Test Standards

- HMIs can be tested to
  - PDI-G101
  - ASME 112.14.3
  - CSA B481.1
  - CSA B481.2
  - EN 1825-1

Existing Test Protocols

Existing Performance Test Standards Cont'd

- GGIs can be tested to:

But seriously….

- There are in fact some protocols for larger interceptors:
  - IGC 273-2009 was intended for interceptors over 100 gpm, never used. Basically PDI with more sinks.
  - NSF SE 15741 is for interceptors with capacities over 200% of the minimums defined in A112.14.3 i.e. 4 lbs/gpm

- They have never been used because they are impractical, perhaps impossible
  - NSF has run 15741 and apparently it worked well, though the data is not public

Impractical

- The HMI capacity requirement is defined in terms of flow rate, 2 lb grease/gpm
- The detention time rule of thumb effectively makes volume equal to flow rate so capacity requirement becomes 2 lb grease/gallon of interceptor volume
- If a “typical” GGI has a 1000 gallon volume, that is 1 ton of grease

Lard

- Melting 2000 lb of lard requires:
  - Someone to manage lard more or less full time
  - Energy consumed would be around 40 kWh, not that much but all waste
- This lard, which costs ~0.70/lb to buy, is also waste

Time

- IGC 273 & PDI G-101 allow testing of higher flow interceptors (we will assume this means higher volume too) using the same test PDI G-101 test

- 100 gpm PDI test can be run in one day and will result in retention of ~200 lb of lard, so a 1000 gallon GGI will require 10 days of testing
  - Impact of stopping at night and on weekends?

- NSF 15741 allows acceleration that should reduce the required number of runs to ~30 which makes it a 3 day test

NSF SE 15741

- A 3-5 day that wastes ~$1400 with of lard is not ideal but why not use it?
- It will not be 3-5 days and $1400
  - It will be much more painful than that

An HMI test for GGIs

- An HMI turns over ~2 complete volumes each run, under the circumstance 90%+ removal is very impressive
- A 1000 gallon GGI will turnover ≤20% of its volume each run, it would have to be designed to fail in order to get <90% removal
- Assuming efficiency equivalence in terms of volumes treated actually puts you at a factor of 20 so assuming 10 times the runs is conservative

Scaling the Test

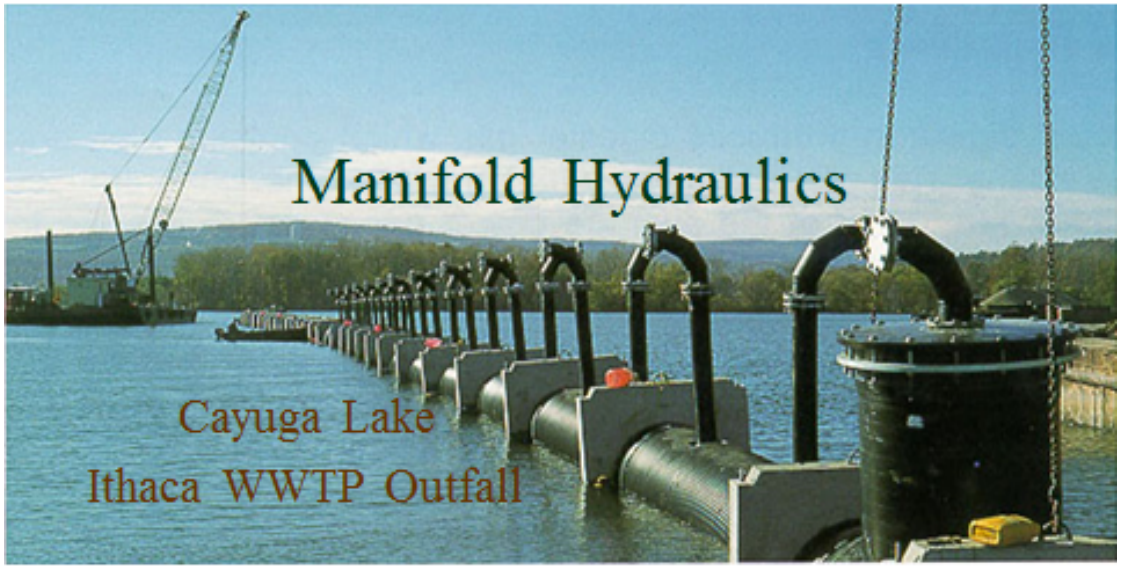
- PDI and NSF allow for > 100 gpm flow rate per test by adding more sinks
- Note that scaling flow requires scaling volume and vice versa
- This is where the “impossible” from slide 14 comes in
  - Flows over 100 gpm probably don’t make sense and there is no option to scale just volume

Impossible?

- The existing protocols call for adding identical sinks in series in order to achieve the desired flow rates for testing above 100 gpm
  - This adds resistance (more pipe) but no more driving force so flows will not increase as expected. There is also the challenge of balancing flows in a manifold. I do not think anyone knows what will actually happen

Manifolds

According to this presentation…



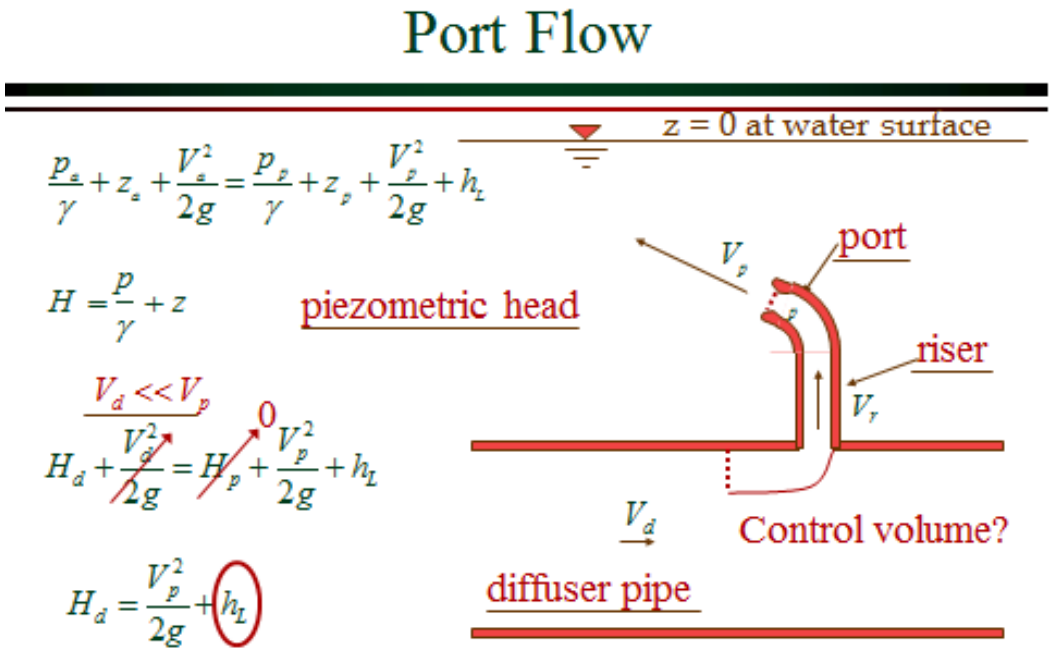
Monroe L. Weber-Shirk

School of Civil and Environmental Engineering

Cornell University

Manifolds (Cont'd)

Calculating Flow through Manifolds looks something like this…



Manifolds (Cont'd)

And this…

Riser Head Loss

$$h_L = h_{entrance} + h_{riser} + h_{elbow}$$

$$h_L = \left(K_{en} + f\frac{L_r}{D_r} + K_{el} \right)\frac{V_r^2}{2g}$$

$$h_{el} = K_{el}\frac{V_r^2}{2g}$$

$$V_r D_r^2 = V_p D_p^2 \qquad \text{continuity}$$

$$h_{riser} = f\frac{L_r}{D_r}\frac{V_r^2}{2g}$$

$$V_r^2 = V_p^2\left(\frac{D_p}{D_r}\right)^4$$

$$h_L = \left(K_{en} + f\frac{L_r}{D_r} + K_{el} \right)\left(\frac{D_p}{D_r}\right)^4\frac{V_p^2}{2g}$$

$$h_{en} = K_{en}\frac{V_r^2}{2g}$$

Manifolds (Cont'd)

And this…

Riser Head Loss Coefficient

$$H_d = \frac{V_p^2}{2g} + h_L$$

$$H_d = \left[1 + \left(K_{en} + f\frac{L_r}{D_r} + K_{ei}\right)\left(\frac{D_p}{D_r}\right)^4\right]\frac{V_p^2}{2g}$$

$$K_r = 1 + \left(K_{en} + f\frac{L_r}{D_r} + K_{ei}\right)\left(\frac{D_p}{D_r}\right)^4$$

(riser loss coefficient) Note that the riser coefficient is a function of Reynolds number.

$$H_d = K_r\left(\frac{V_p^2}{2g}\right)$$

$$V_p = \sqrt{\frac{2gH_d}{K_r}} \qquad Q_p = \frac{\pi D_p^2}{4}\sqrt{\frac{2gH_d}{K_r}}$$

Port velocity (or flow) given piezometric head in diffuser and a riser loss coefficient

Orifice equation!

- And even so there are empirical coefficients

Future GGI Protocol

Future GGI Testing

- There was an IAPMO subcommittee, Z1001.1, that was working on a GGI protocol but as far as I know this effort has stalled

- This leaves the field wide open for protocol development, with the significant constraint that the test must be reasonably comparable to PDI-G101
  - The end user needs to be able to compare

Addressing the Lard Problem

- CSA B481.2 uses oil instead of lard
  - The injection method is also different but that need not be adopted
  - Matching density and viscosity should not be too difficult

- This is much faster and less wasteful
  - Water does not get frozen in the oil matrix so oil recovery is possible

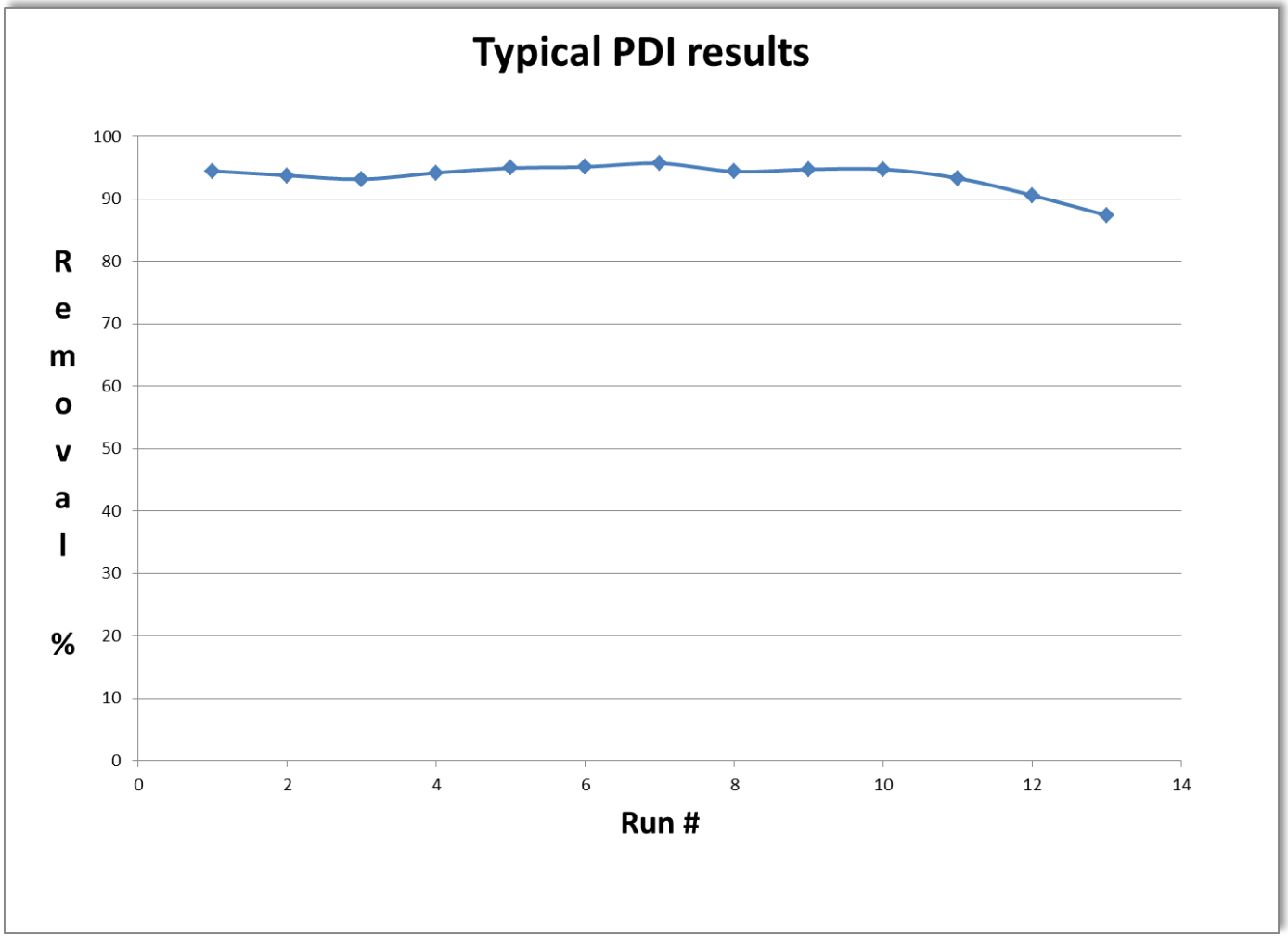
Addressing the Time Problem

- NSF SE 15741 proposes adding lard through the lid and alternating sink dumps and pre-loads
- This concept of pre-loading could be refined to require pumping in lard or adding extra large amounts through sink dumps
- Switching to oil makes this easier and eliminates some of the issues of running for >1 day

Addressing the Time Problem (Cont'd)

- PDI allows computation of efficiency once every 5 increments or less until near the end
- PDI curves are not published but I think we all know they look something like this

Addressing the Time Problem (Cont'd)



Addressing the Time Problem, Grand Finale

- Based on the foregoing, one can imagine pre-loading relatively large amounts and running a few sink dumps for the first 1000+ pounds
  - This would save hours and dollars

A fly in the grease trap

- A commonly mentioned problem with switching to oil is measuring oil in water
  - The old method, hexane extraction, works very well but is out of favour
  - FTIR is difficult to implement so results are variable
  - GCMS would work well but it expensive
- Why not just skim
  - The methods above are accurate to ppm but the existing analytical technique is not and that creates a double standard. Gravimetric all the way!

Conclusion

- A reasonable test for GGIs that would allow them to be compared to HMIs is possible, though challenges remain
  - Not just technical, there are acceptance issues

- You will note I have not addressed the issue of storage time and acidification, that is a different issue
  - I am not sure the science is all the way there yet and in any case it has nothing to do with removal

Q&A

- I am genuinely interested in feed back since this is all at the idea stage

Thank you