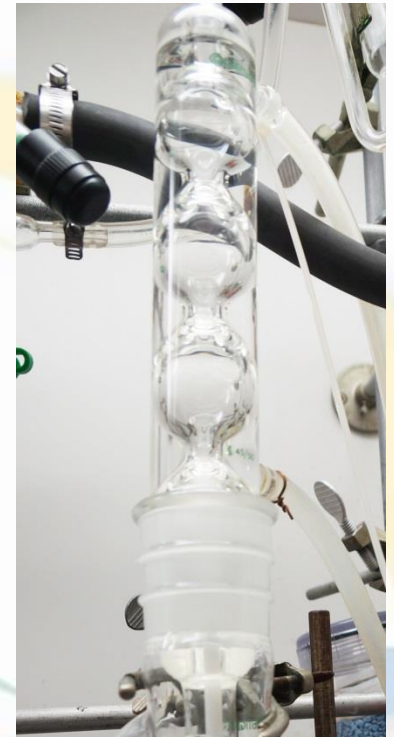


A Sustainable Alternative to Single Pass Cooling Systems

Amorette Getty, PhD
Co-Director, LabRATS

What is Single Pass Cooling?

- Used for distillation/reflux condensers, ice maker condensers, autoclaves, cage washers...
- Use a continuous flow of water from faucet to sewer
 - 0.25-2 gallons per minute,
 - up to 1,000,000 gallons of water/year if left on continuously



Single Pass Cooling: Support

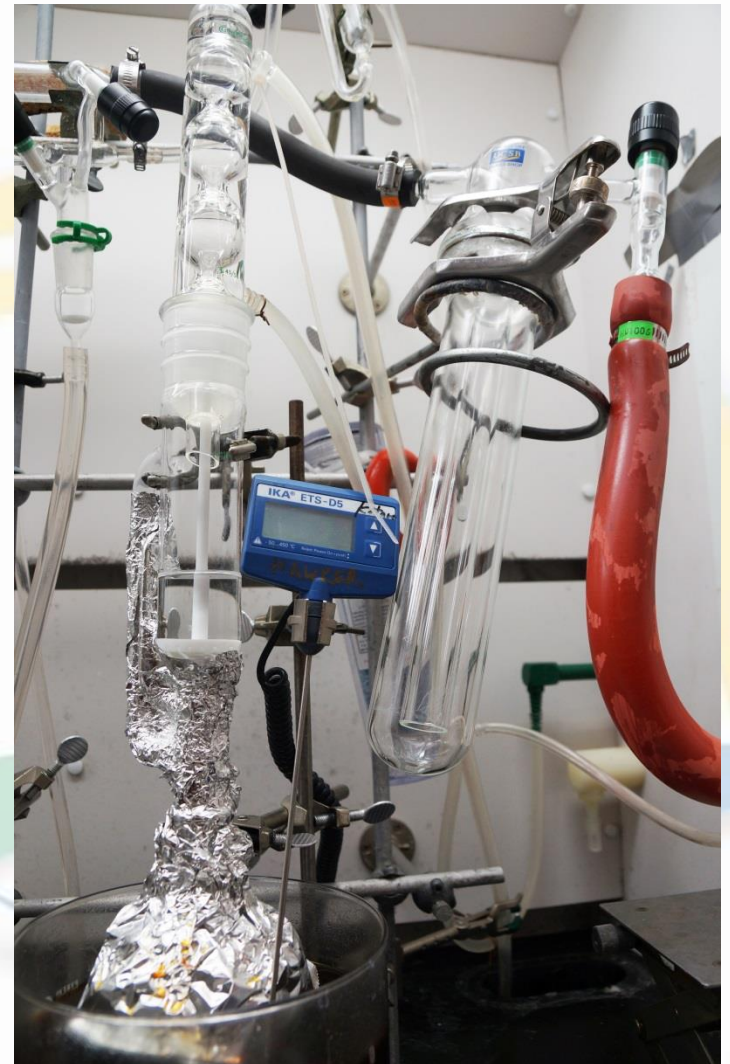
- “U.S. Environmental Protection Agency has ranked the elimination of single-pass cooling systems #4 on its list of top ten water management techniques”

-Steve Buratto, Chair of Chemistry and Biochemistry department

NOT Just a Sustainability Issue!

California Nanosystems Institute (CNSI) **flood** in a second-floor laboratory in July, 2014.

Water ran at ~1-2 gallons per minute for 6-10 hours, overflowing into a ground floor electron microscopy lab



CNSI Flood Losses

- \$ 2.2 Million in custom built research equipment
- Research shutdown for 4 months
- over 200 hours of staff time
- Insurance no longer covering this type of incident again

Campus Responses to the Incident

- CNSI ban on single pass cooling systems
- TGIF grant financial incentive for optional change of single replacement systems
 - Chemistry and Material Research Laboratory (MRL)
- Additional Grants being sought
- Conversation at Campus and UC-level to regulate and replace these types of systems.

Seeking Allies...

- “The replacement of single-pass cooling systems with closed-loop and water free systems would save water and represent a major advance in the sustainability efforts of the campus.”
-Steve Buratto, Chair of Chemistry and Biochemistry department

Barriers to Replacement

- “...major obstacle to replacing the single-pass cooling systems with closed-loop and water-free systems is cost. The department budget simply does not allow for this expense.”

-Steve Burrato, Chair of Chemistry and Biochemistry department

Alternative Condenser Technologies

Simple Recirculating Bath

- Cost : ~\$50 to \$160
- up to 1 gpm
- Suitable for gas condensing
- No installation required
- Can be as simple as an ice-water bucket and aquarium/fountain pump



Recirculating bath with Plumbed Heat Exchange

- Cost: approx. \$2600
- Flows rate : 0.5 gallons/ minute
- Requires installation to connect to building chilled water loop, extra plumbing cost
- Suitable for most application in laboratories
- Recirculating bath with built in heat exchange could be used for permanent or long term distillation setups

Radleys' Findinser Condenser

- Cost : approx. \$400
- Flow rate: Uses No water
- No Installation required
- Aluminum foil for heat exchange
- Suitable for 95% of chemistry application
- “217 Findensers were purchased and distributed by EH&S with funding from our Clean Water Utility and BSAS funds. The cost was \$65,000. The water savings is estimated at 17 MGAL/YR. The water \$ savings is \$170,000/YR.” (Above image at <http://www.radleys.com/news/press-releases/findenser-a-fantastic-innovation-says-university-of-california-researchers>)



Water Use/Savings Estimate Equation

gallons per minute (gpm) per condenser	x	fraction of time condenser is in operation	x	number of condensers in such use on campus	=	total gallons of water per year
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Condenser Gallons Per Minute (GPM)

Source	Estimate	Explanation
Engaging lab users through best practices, green chemistry to achieve sustainability (Laboratory Design)	0.5 gpm	200,000 gallons per year from a single reaction condenser (measurement from a very high-use lab, more general estimate see GaTech below).
Environmental Protection Agency Water Sense	0.54 gpm	for single-pass cooling of an ice machine, 283,000 gal/year
Laboratories for the 21st Century	1.5 gpm	trickle-flow for single-pass laboratory equipment cooling, 788,400 gal/year
Georgia Tech	0.25 gpm	4 hr/day, ~15,000 gal/year
UCSB CNSI	1-2 gpm	Condenser involved in the floor incident last year

Fraction of time condenser is in use

Source	Estimate	Explanation
Alex Moretto, Chemistry	48 to 60 hours a week	Average graduate student
Georgia Tech	20hrs a week	Five 4-hr reactions totaling 20hrs a week

Number of Condensers in Use on Campus

- Estimations by researcher or by number of condensers?
- 160 researchers in Chem/PSBN alone
- Note for calculations on replacements: we are not replacing the condensers themselves (researchers often have several); we are replacing the cooling source (1-2 per researcher)

CALCULATIONS WITH A RANGE OF ASSUMPTIONS:

Range of weekly usage estimates (in gallons) for one condenser setup:

Usage Rate:	0.25 gpm	0.5 gpm	1 gpm	2 gpm
16 hrs/week	240	480	960	1,920
48 hrs/week	720	1,440	2,880	5,760
60 hrs/week	900	1,800	3,600	7,200
72 hrs/week	1,080	2,160	4,320	8,640

Annual Usage for above weekly estimates, in gallons,
for 85 users, 40 weeks per year

Usage Rate:	0.25 gpm	0.5 gpm	1 gpm	2 gpm
16 hrs/week	816,000	1,632,000	3,264,000	6,528,000
48 hrs/week	2,448,000	4,896,000	9,792,000	19,584,000
60 hrs/week	3,060,000	6,120,000	12,240,000	24,480,000
72 hrs/week	3,672,000	7,344,000	14,688,000	29,376,000

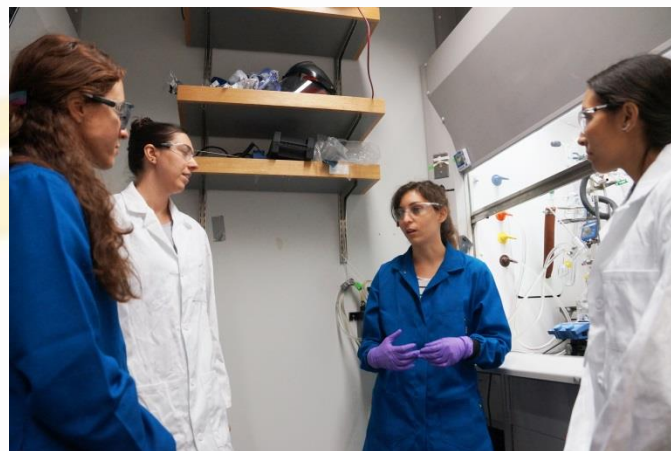
Annual Usage for weekly estimates, in gallons, 200 users, 50 weeks per year

*% noted below are the % of the total potable water usage for UCSB
in the performance year of last STARS report: 217,943,205 Gal.*

Usage Rate:	0.25 gpm	0.5 gpm	1 gpm	2 gpm
16 hrs/week	2,400,000 (1.1%)	4,800,000 (2.2%)	9,600,000 (4.4%)	19,200,000 (8.8%)
48 hrs/week	7,200,000 (3.3%)	14,400,000 (6.6%)	28,800,000 (13.2%)	57,600,000 (26.4%)
60 hrs/week	9,000,000 (4.1%)	18,000,000 (8.3%)	36,000,000 (16.5%)	72,000,000 (33%)
72 hrs/week	10,800,000 (5%)	21,600,000 (9.9%)	43,200,000 (19.8%)	86,400,000 (39.6%)

Funding Efforts at UCSB

- \$34,994 to replace 54 units
 - UCSB TGIF
 - Be Smart About Safety
 - 21 units in MRL
 - 20 units in Chemistry
- 85 units requested in chemistry, MRL, CNSI
 - 37 units in MRL
 - 20 units in Chemistry
 - 28 units in CNSI
- Campus-wide need estimate: 200 units?



Questions, Thoughts, Ideas?

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