

Future Directions for Lithium Bromide Absorption Chillers

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Future Directions for Lithium Bromide Absorption Chillers

**Jay Kohler – York
International Corp.**

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General Comments

- **Discussion focused on**
 - **US market**
 - **Lithium bromide/water equipment**
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Topics

- **Present Situation – Technical and Market Issues**
 - **Future Directions – Technical and Market Issues**
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Present Situation – Technical and Market Issues

Present Situation

Technical Issues

- **Fluids**
 - **Absorbent: Lithium Bromide**
 - **Refrigerant: Water**
 - **Additives: Alcohol, Corrosion Inhibitors (molybdate, nitrate, proprietary inhibitors)**
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Present Situation

Technical Issues

- **Cycles**
 - **Single-Effect**
 - **Double-Effect**
 - **Solution circuiting (parallel, series, inverse series)**
 - **Different approaches to recover heat internally**
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Present Situation

Technical Issues

- **Heat Exchanger Technology**
 - **Absorber/Evaporator/Condenser/Low Temperature Generator**
 - **Primarily shell & tube design**
 - **Bundle design**
 - **Liquid distribution**
 - **Enhanced tubes (more limited)**
 - **Liquid-to-liquid**
 - **Shell & tube**
 - **Plate HX**
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Present Situation

Technical Issues

- **Chiller Design**
 - **Advanced controls**
 - **Automatic purging**
 - **Solution concentration limiting**
 - **BAS interface**
 - **Focus on leak tight design and manufacture**
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Present Situation

Market Issues

- **Products**

- **Single-Effect**

- **COP ~ 0.7**

- **Steam (predominant in US, low pressure – 15 psig)**

- **Hot water (hot fluid)**

- **Capacities primarily 100 to 1500 Tons**

- **Water cooled only (no air cooled)**

Present Situation

Market Issues

- **Products (Continued)**
 - **Double-Effect**
 - **COP ~ 1.0+**
 - **Direct-fired (natural gas, other clean fuels) , Steam (medium pressure – 115 psig) , Hot fluid , Exhaust gas**
 - **Capacities primarily 100+ Tons**
 - **Water cooled only (no air cooled)**
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Present Situation

Market Issues

- **Alternatives to absorption**
 - **Electric driven chillers**
 - **Other gas/steam**
 - **Gas engine driven**
 - **Steam turbine driven**
 - **Absorption chiller costs, relative to electric drive:**
 - **Single-effect \sim 20% higher price**
 - **Double-effect \sim 80 - 100% higher price**
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Present Situation

Market Issues

- **Where to consider absorption?**
 - **High electrical costs (high rates, lack of service)**
 - **Gas cooling incentives**
 - **Hybrid facilities**
 - **Inexpensive steam or hot water**
 - **Waste heat source (gas engine jacket water, flue gas, process steam or hot water)**
 - **Turbine inlet air cooling**
 - **Cooling and heating capability from one product**
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Natural Gas Historical Prices



Present Situation

Market Issues

- **US Absorption Market size and direction – US industry figures**

1991 **\$19 million**

1996 **\$67 million**

2002 **\$22 million**



Present Situation

Market Issues

- **Worldwide market for Absorption chillers in 2001:**

\$549 million

China	52%
Japan	21%
US	7.8%
Korea	6.5%



Source: JARN (chillers > 100 Tons)

Present Situation

Market Issues

- **For comparison, the worldwide market for Centrifugal chillers in 2001 was \$853 million**

Source: JARN

Future Directions – Technical and Market Issues



Future Directions

Caveat

- **Comments are based primarily on publicly available information. Companies generally don't disclose research or market plans.**

Future Directions

Technical Issues

- **Fluids**

- **Lithium Bromide/water likely to remain**
 - **Additives have been studied (reduced susceptibility to crystallization, increased range for possible air-cooled application)**
 - **Alcohol – surprisingly, nothing seems to beat 2-Ethylhexanol**
 - **Corrosion additives – most likely area for change**
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Future Directions

Technical Issues

- **Cycles**
 - **Continued dominance by single- and double-effect**
 - **Maximize the internal recovery of energy to increase chiller COP**
 - **Triple effect – technically feasible – high initial cost**
 - **Others - 1/2 effect?**
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Future Directions

Technical Issues

- **Heat Exchanger Technology**
 - **Proprietary developments (research reports, patent literature)**
 - **Tube bundle configurations**
 - **Liquid feeding mechanisms**
 - **Tube enhancement**
 - **Tube wettability**
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Future Directions

Technical Issues

- **Chiller Design**

- **Focus on reduced chiller cost, improved COP, improved reliability**
 - **Reduced emissions from direct-fired chillers**
 - **Continued improvement of chiller controls (anticipatory controls, improved sensors)**
 - **Continued focus on leak tight design and manufacture**
 - **Design integration with other equipment for heat recovery applications**
 - **Air-cooled?**
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Future Directions

Market Issues

- **Market drivers**
 - **High electrical peak load cost & reliability of supply**
 - **Fluctuations in natural gas prices**
 - **Price differential of electric vs. absorption**
 - **Familiarity with absorption**
 - **Environmental & Legislative issues (ASHRAE 90.1 for example)**
 - **Support from governmental and industry organizations**
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Future Directions

Market Issues

- **Possible Approaches**
 - **Hybrid equipment rooms**
 - **Integration of absorption with distributed power generation**
 - **Growing interest in CHP**
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Future Directions

Market Issues

- **Heat Recovery**
 - **Cooling provided with no additional fuel consumption**
 - **No added CO₂, NO_x, HC emissions from primary energy source**
 - **Needs to be economically viable**
 - **Recover heat directly in the generator vs. use of a heat recovery fluid**
 - **Micro-turbines, Fuel cells**
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Future Directions

Market Issues

- **Heat Recovery (Continued)**
 - **Relationship between source temperature and cooling capacity**
 - **For a single-effect chiller, reducing the entering hot water temperature from 240°F to 200°F reduces chiller capacity by about 40%**
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Future Directions

Market Issues

- **Other**
 - **Significant opportunity for small capacity (<100 Tons), but market wants a dry air-cooled packaged product. The low capacity end of this market is addressed with ammonia/water absorption chillers.**
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Future Directions

Market Issues

- **Which direction is the US absorption market headed? Up? Down? Sideways?**
- **Short term?**
- **Long term?**



Conclusions

- **Lithium bromide/water based single- and double-effect chillers will continue to dominate the US absorption market**
 - **There has been a fall-off in the absorption market in the US since the mid-1990's**
 - **Absorption remains a viable approach for many applications**
 - **Change in energy markets mean uncertainty in the future and opportunities for gas cooled products**
 - **Heat recovery applications can produce cooling without added emissions**
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