ARCH633 Environmental Systems I

Assignment 9:
Conduction

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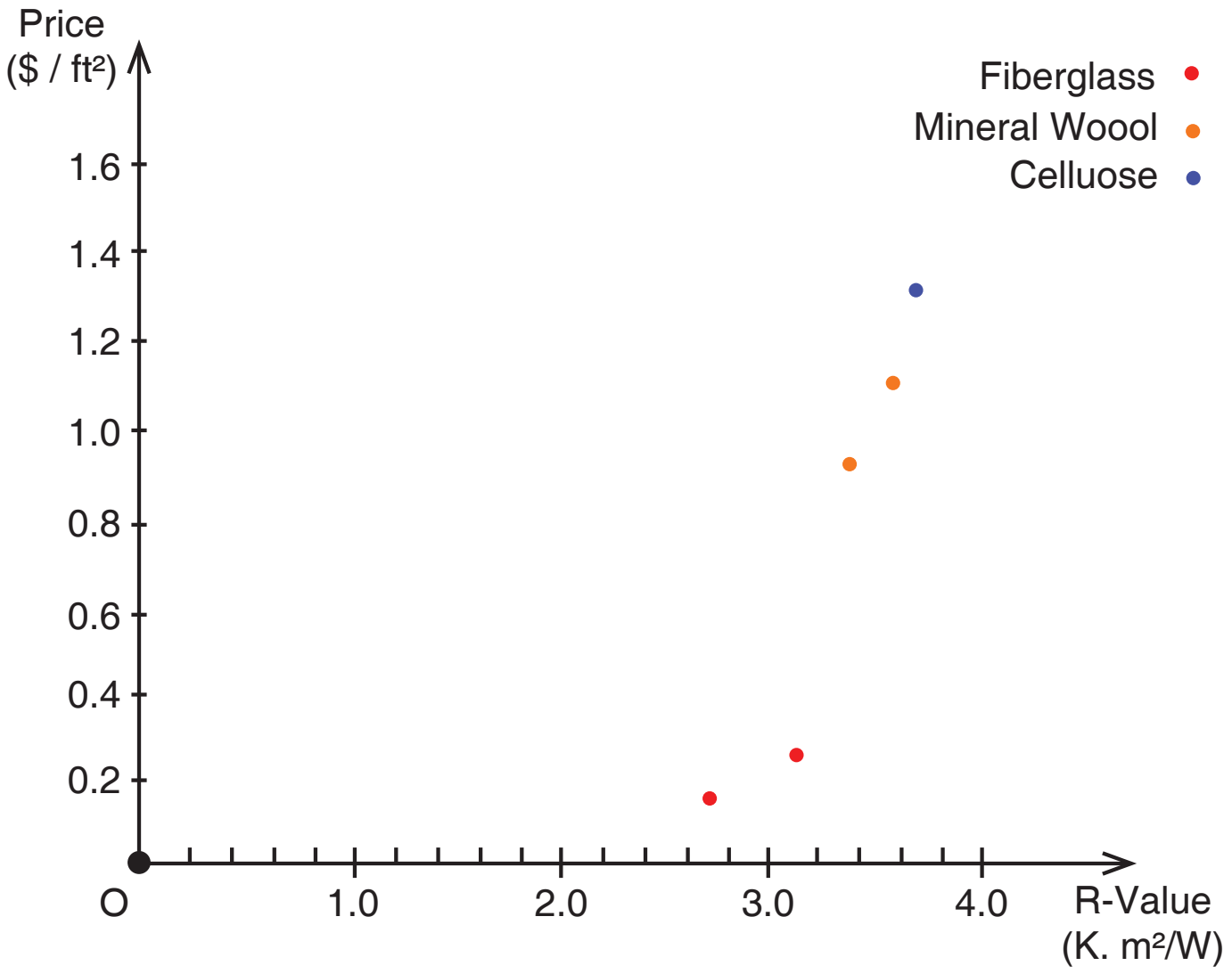
3 Typical Insulation Materials

Materials	Definition	R-Value	Price
Fiberglass	Consists of extremely fine glass fibers One of the most ubiquitous insulation materials Commonly used in two different types: - Blanket (batts and rolls) - Loose-fill Available as rigid boards and duct insulation	**Batts** **2.9 - 3.8** per inch **Loose** **2.2 - 2.9** per inch	**Batts (R11)** **$0.12-$0.16** per feet^2 **Batts (R13)** **$0.15-$0.20** per feet^2
Mineral Wool	Formed by spinning or drawing molten minerals Contains 75% post-industrial recycled content Typically refers to two types of insulation material: - Rock wool, man-made consisting of natural minerals - Slag wool, man-made from blast furnace slag	**3.7 – 4.2** per inch	**Batts (R15)** **$0.77** per feet^2
Celluose	Made from recycled paper products, primarily newsprint High recycled material content, generally 82% to 85% Add the mineral borate Sometimes blended with less costly ammonium sulfate	**3.1 – 3.8** per inch	**$0.86-$1.39** per feet^2

Insulation Materials Chart



Insulation Scatterplot Chart

3 Typical Window Assemblies

Definition & Relationship

Assembly U-Factor: The “area weighted” average thermal transmittance of all components.
Center-of-glass U-factor: Referenced and describes the performance of the glazing alone without the effects of the frame. For most energy efficient windows, the whole window U-factor is higher than the center-of-glass U-factor.

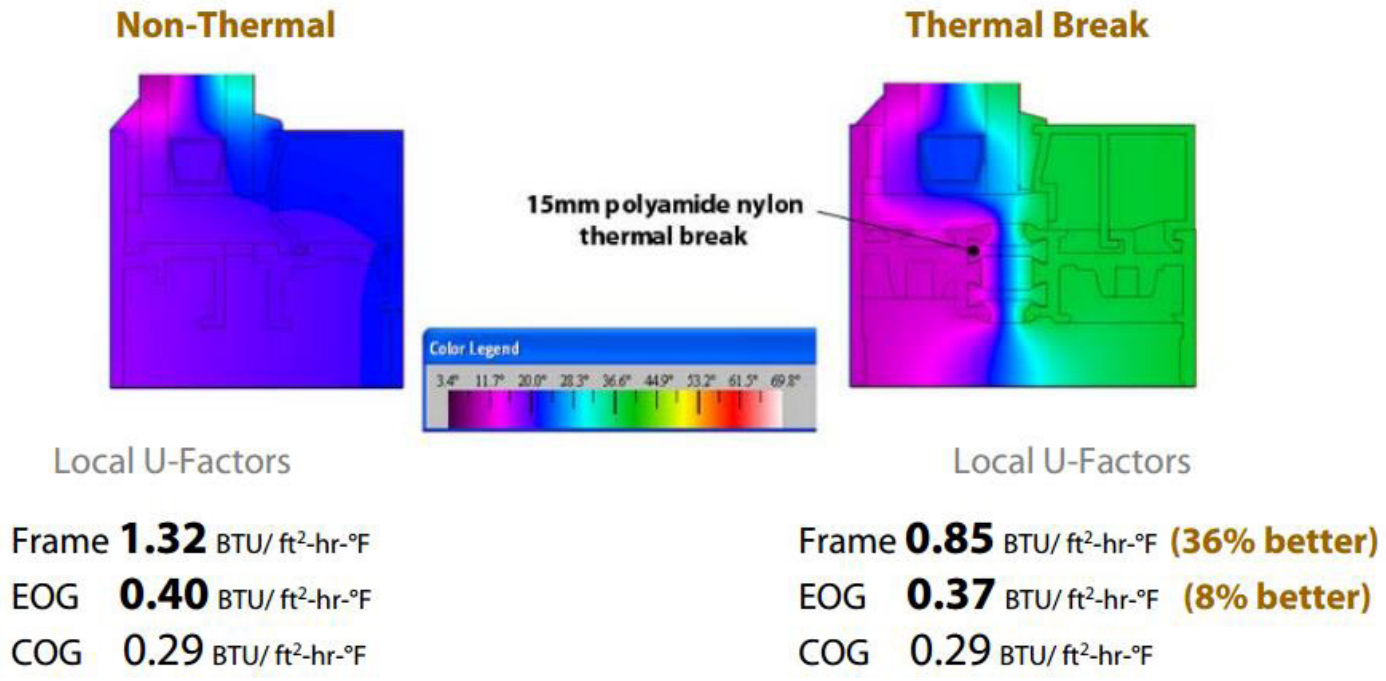
Three components are used to calculate U-Factor:
- **Center-of-glass (COG)**: Typical value 0.29 BTU/ ft^2-hr-°F (low-e IG)
- **Edge of Glass (EOG)**: Typical value 0.34 BTU/ ft2-hr-°F (aluminum spacer)
- **Frame:** Typical value 0.90 BTU/ ft2-hr-°F (thermal break)

Assembly U-Value = $((U_{Frame}*Area_{Frame})+ (U_{EOG}*Area_{EOG})+ (U_{COG}*Area_{COG}))$ / Total Area

- Frame U-Value includes heat transfer through surfaces perpendicular to the glass plane.
- The center-of-glass U-Value is the best-performing component of non-residential window assembly.
- Window area and configuration can significantly affect the overall window assembly U-Value.

Window Assembly I: Frame Type

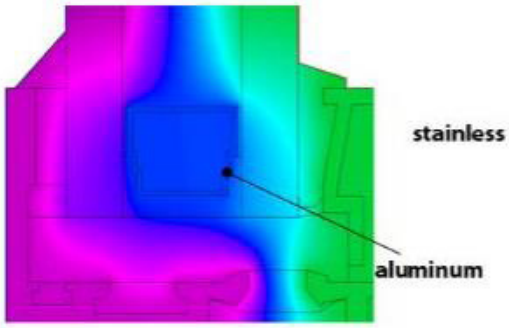
- Thermal barriers in frames also improve EOG performance
- Other frame effects include (in order of their impact on local U-Value), mullion depth, emissivity of aluminum finish, glass set-back from the exterior, sightline, extrusion wall thickness, and number of frame extrusion webs.



Window Assembly II: Glass Spacer

- nsulating glass spacers can affect frame U-value more than EOG U-Value
- While difference in U-Factor is relatively minimal, note that surface temperature warms by 3 to 4 °F at standard conditions, forestalling condensation.

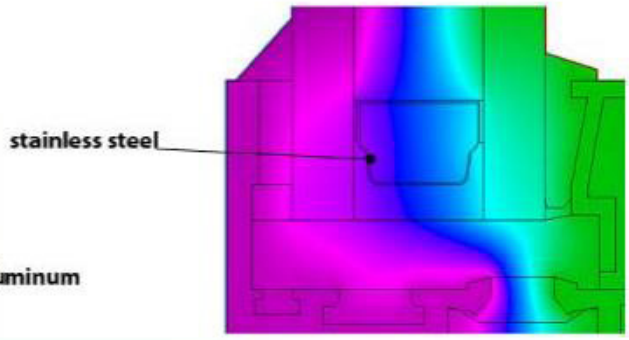
Standard Aluminum Spacer



Local U-Factors

Frame **0.85** BTU/ ft²-hr-°F
EOG **0.37** BTU/ ft²-hr-°F
COG 0.29 BTU/ ft²-hr-°F

Stainless Steel "Warm Edge" Spacer



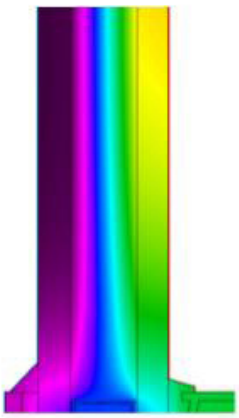
Local U-Factors

Frame **0.79** BTU/ ft²-hr-°F **(7% better)**
EOG **0.35** BTU/ ft²-hr-°F **(5% better)**
COG 0.29 BTU/ ft²-hr-°F

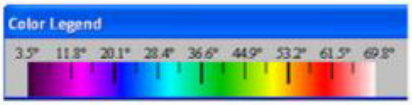
Window Assembly III: Gas Fill

- Gas fill affects COG U-Factor much more than EOG U-Factor.
- Argon gas will dissipate from an insulating glass unit. The rate at which this occurs depends upon the type of edge seal, the quality of materials, and manufacturing assembly processes.

Air space in IG



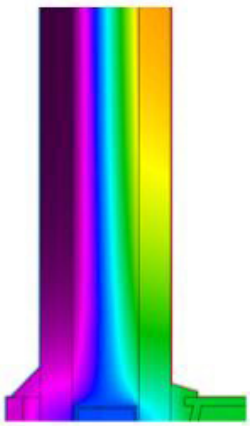
1" Insulating low-E coated



Local U-Factors

COG **0.29** BTU/ ft²-hr-°F
EOG **0.37** BTU/ ft²-hr-°F
Frame 0.85 BTU/ ft²-hr-°F

Argon-filled space in IG



Local U-Factors

COG **0.24** BTU/ ft²-hr-°F **(17% better)**
EOG **0.34** BTU/ ft²-hr-°F **(8% better)**
Frame 0.84 BTU/ ft²-hr-°F