Managing Increasing Reservoir Pressures for Depleted Gas Field Storage

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**Image**: Diagram showing the pressure profile and phase transitions in reservoirs.

**Text**: Strategies for depleted gas field injection:
1. Use large bore tubing and accept unstable flow and low temperature. Maintain single-phase flow in pipeline through choke.
2. Use downward adjustable choke to maintain single phase flow in tubing (gas then dense phase). Low temperatures and uncertain track record in this environment.
3. Use smaller diameter tubing to spread frictional pressures and disperse low temperatures.
4. Manage pressures through use of multiple wells.

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**Text**: Ideal abandonment rock-to-rock plug, existing casing and cement underreamed.

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**Text**: Tree and Wellhead temperature may drop below -50°C. Arctic grade wellheads useful with no elastomeric seals.

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**Text**: The ‘B’ annulus could be displaced to an inert fluid to provide monitoring of fluids and prevent CO₂ induced corrosion.

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**Text**: Hydrate forms due to cooling CO₂ – hydrate ‘snow’ causes tubing blockages.

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**Text**: Supercritical CO₂ is relatively dense and aids in injection (reduced surface pressure).

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**Text**: If CO₂ expansion or vaporisation expected, this annul (at least) will require freeze protection, consider insulation to protect outer annulus and casing.

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**Text**: Tubing size – larger is better for aquifer injection.

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**Text**: An ‘open hole’ on a platform well provides a monitoring opportunity for migration past the cap rock.

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**Text**: Wet CO₂ is highly corrosive to carbon steels. Free water possible with CO₂ expansion/vaporisation.

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**Text**: A microannulus and a short cement column may allow long term leakage around the cap rock.

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**Text**: Packers positioned across cap rock to avoid potential leak path via exposed production casing.

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**Text**: The metallurgy of the casing/liner adjacent to the cap rock requires CO₂ resistant metallurgy such as duplex unless interval is long enough for reaction to be restricted by slow diffusion.

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**Text**: Dissolved CO₂ slowly attacks and weakens conventional (Portland) cements. Diffusion and permeability reaction products limits damage.

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**Text**: CO₂ initially rises due to buoyancy until trapped by the cap rock. Long term, the CO₂ dissolves in water and slowly sinks.

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**Text**: Shell fragments, calcite cement and other acid soluble minerals can dissolve, but possibly precipitate later.

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**Text**: Cold CO₂ initially mixing with connate water creates theoretical hydrate rise near wellbore, dehydration likely before temperatures decline so risk is low.

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**Text**: Unstable CO₂ injection e.g., dense phase slugs and low temperatures can create sand production potential especially if crossflow likely when well is shut-in.