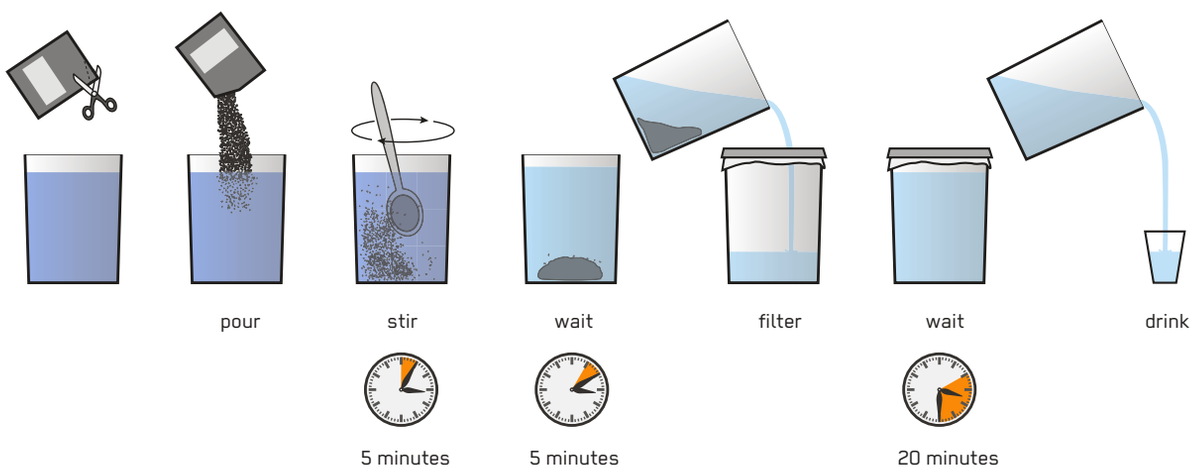
Coagulation, Sedimentation and Chlorination

Response Phase	Application Level	Management Level	Objectives / Key Features
** Acute Response * Stabilisation Recovery	** Household Neighbourhood City	** Household Shared Public	Point-of-use treatment, mechanical pathogen removal and disinfection
Local Availability	**Technical Complexity**	**Maturity Level**	
** Medium	* Low	*** High	



Combined Coagulation, Sedimentation and Chlorination is available for household use as small sachets of coagulant and a time-release form of chlorine. The coagulant reduces turbidity ('muddiness'), while the chlorine, which activates after some time, disinfects by inactivating pathogenic microorganisms. A single sachet treats a volume of water defined by manufacturer (e.g. 10 or 20 L) within 30 minutes.

In Coagulation, chemicals added to the water destabilise the electrostatic charge on colloids so they come together to form larger particles (Flocculation), which then settle out more quickly (Sedimentation). Since pathogens such as bacteria, protozoa and viruses tend to attach themselves to particles, a large reduction in pathogens occurs through Sedimentation alone. Chlorine is then released into the reduced-turbidity water to further inactivate the remaining microorganisms more effectively and at a lower chlorine concentration than would be needed to treat turbid water. With this dual-action system, considerable pathogen removal can be achieved, as chlorine alone does not inactivate certain organisms (e.g. protozoa such as Cryptosporidium and Giardia). The treated water containing free residual chlorine is protected against recontamination.

Design Considerations: The powder from the sachet is added to water and stirred vigorously for 5 minutes. The water then sits for a further 5 minutes, during which time the flocs (larger particles) settle. The water can then be decanted and/or filtered through a cloth made of cotton or synthetic fibre and left for another 20 minutes to allow enough contact time for the chlorine. Usually, the dose is proposed by the manufacturer to assure at least 0.5 mg/L residual chlorine is available to protect against recontamination, but in reality, concentrations can vary widely depending on factors such as the quality of raw water, type of coagulant, temperature and the age of the sachet. The method is most efficient for water with a pH between 5.5 and 7.5, although less efficient Coagulation will still occur

at a lower pH. If the coagulant is over- or under-dosed, Sedimentation will not occur to the required extent, and the concentration of free chlorine may not be sufficient to disinfect. At a high pH (> 9), the method is unreliable.

Materials: The sachets are sold by only a few manufacturers. This method requires regular or periodic purchase or distribution of the sachets, as well as two containers of the required volume. Treated water should preferably be stored in a safe water container, such as a jerrycan or bucket with a tap and lid **(see H.1)**.

Applicability: Disinfection using chlorine is relatively quick, simple, inexpensive and applicable when water is bacterially contaminated. Combined with Coagulation, it is also suitable for turbid waters or when turbidity may vary. The method has proven to be very effective in acute emergency situations as a first response (e.g. to cholera epidemics) as well as for dispersed populations where setting up bulk water treatment is difficult.

Operation and Maintenance: Disinfection with combined Coagulation, Sedimentation and Chlorination can be easily learned and must be regularly carried out. Allowing sufficient time for particles to settle can be an issue for some users. If the source water is turbid, sediment may settle at the bottom of container, and the water must then be withdrawn carefully to not disturb these sediments. During cleaning, the sediments must be removed from the container. Apart from cleaning and occasional replacement of containers and utensils, no maintenance is needed. Coagulation combined with Chlorination requires a constant supply of treatment sachets that users must be able to purchase regularly, or the organisation needs to distribute chemicals frequently. Chlorine may degrade over time or if improperly stored. Usually the shelf life of sachets is 3 years, but this reduces at high temperature, humidity or exposure to direct sunlight. The open packages should be used quickly.

Health and Safety: Coagulation combined with Chlorination at concentrations provided by manufacturers is efficient for inactivating bacteria, viruses and protozoa. According to the evaluation of household water treatment performed by the WHO, it removes 99.99 % of viruses, 99.9999 % of bacteria and 99.9 % of protozoa under laboratory conditions. High organic matter content in the water leads to the formation of disinfection by-products (DBPs) during Chlorination. However, studies show that in combination with Coagulation, the formation of DBPs is reduced. Regardless, the long-term potential health risks from these by-products are low in comparison with the confirmed acute risks associated with inadequate disinfection, and disinfection should therefore not be compromised in the acute phase of the emergency by attempting to control DBPs. The powder must be handled carefully, as it can irritate the skin, eyes and respiratory system. The sediments formed during treatment should be disposed of with care as they might still contain pathogens and chemicals.

Costs: The in-country price of the sachet is 0.1 USD (or 0.01 USD per litre of water treated). For acute emergencies, the product might be sold by manufacturers at the factory price of around 0.0035 USD per sachet, without including shipping or import costs.

Social and Environmental Considerations: Acceptance is supported by the clear water that visibly results from the treatment of turbid water, and this method is usually well understood. However, the chlorine taste and odour after application can make some users hesitant. Waiting times might not always be respected. Users require basic training and ideally a follow-up training to assure consistent and correct use. Continuous monitoring of product use is required to assure the health risks due to potential misuse are low. Waste management recommendations for disposal of sediments and packaging might be required.

Strengths and Weaknesses:

⊕ Is easy to apply and reliable for inactivating bacteria, protozoa and viruses
⊕ Provides residual chlorine for avoiding possible recontamination
⊕ Effectively treats turbid water

⊖ Requires the continual purchase or supply of sachets
⊖ May taste unacceptable to some users
⊖ May deteriorate over time and if stored inappropriately
⊖ Has high costs compared to Chlorination only

→ **References and further reading material for this technology can be found on page 222**